



## School of Refrigeration & Air Conditioning Skills

Session: 2020-21 (Summer Semester)

B. Voc. Program, III Semester,

End-Sem. Examination

Course Code: HVA1301

Course Name: Refrigerant & psychrometry

Time: 2 Hours

Max. Marks: 50

SET -A

### Instruction:

- All questions are compulsory.
- Section A is objective type.
- Section B is short answer type.
- Section C is long answer type.
- Use psychrometric chart as per requirement.

### Section – A

10X01 = 10 Marks

1. What is the measuring unit of specific enthalpy?
  - a) KJ/Kg
  - b)  $\text{m}^3/\text{Kg}$
  - c)  $\text{Kg}/\text{m}^3$
  - d) None
2. What is the measuring unit of specific enthalpy?
  - a) g/Kg of dry air
  - b)  $\text{g}/\text{m}^3$  of dry air
  - c) J/Kg
  - d) None
3. Which type of process is involved in mixing of two air streams in an air conditioning system?
  - a) Adiabatic process
  - b) Polytropic process
  - c) Isobaric process
  - d) None
4. What is the suitable air velocity for human comfort in summer season?
  - a) 15-20 m/s
  - b) 20-40 m/s
  - c) 40-50 m/s
  - d) All of the above
5. Which type of heat is added in through infiltration?
  - a) Sensible heat
  - b) Latent heat
  - c) Both
  - d) None
6. Which type of heat is added in through ventilation?
  - a) Sensible heat
  - b) Latent heat
  - c) Both
  - d) None
7. Which type of heat is added in through internal electrical lights?
  - a) Sensible heat
  - b) Latent heat
  - c) Both
  - d) None



8. During the sensible heating process only, which of the psychrometric property remain constant?

- a) Specific humidity
- b) Relative humidity
- c) DBT
- d) None

9. During the latent heat addition process only, which of the psychrometric property remain constant?

- a) Specific humidity
- b) DBT
- c) Specific enthalpy
- d) None

10. On increasing the temperature of atmospheric air, the relative humidity will be-

- a) Increasing
- b) Reducing
- c) Unchanged
- d) None

**Section – B**

04X04 = 16 Marks

1. Why do we use refrigerant in refrigeration system? How it works in the cycle?

2. Write down the definition of the following:

- A. DBT    B. Specific Volume    C. Specific Humidity    D. Relative Humidity

3. What is sensible heat factor and what does it represent on psychrometric chart?

4. Write short notes on the selection of a refrigerant for a refrigeration system.

**Section – C**

04X06 = 24 Marks

1. Explain different air conditioning processes with the help of Psychrometric chart.

2. explain the concept of RSHF, GSHF and ERSHF.

3. A sample of air has DBT 35° and WBT 25°C. The barometric pressure is 760 mm Hg.

Calculate without using psychrometric chart

- a) Humidity Ratio
- b) RH
- c) Enthalpy of sample

4. In a cooling application, moist air enters a refrigeration coil at the rate of 100 kg of air 35° C DBT and 50% RH. The ADP of the coil is 5° C and the bypass factor is 0.15. Determine the outlet state of moist air and cooling capacity of coil in TR.



**School of Refrigeration & Air Conditioning Skills**

**Session: 2020-21 (Summer Semester)**

**B. Voc. Program, III Semester,**

**End-Sem. Examination**

**ANSWER KEY-A**

**Course Code: HVA1301**

**Course Name: Refrigerant & psychrometry**

**Time: 2 Hours**

**Max. Marks: 50**

**Instruction:**

All questions are compulsory.

**Section – A**

10X01 = 10 Marks

1. What is the measuring unit of specific enthalpy?
  - a) KJ/Kg
2. What is the measuring unit of specific humidity?
  - a) g/Kg of dry air
3. Which type of process is involved in mixing of two air streams in an air conditioning system?
  - a) Adiabatic process
4. What is the suitable air velocity for human comfort in summer season?
  - a) 15-20 m/s
3. Which type of heat is added in through infiltration?
  - c) Both
6. Which type of heat is added in through ventilation?
  - c) Both
7. Which type of heat is added in through internal electrical lights?
  - a) Sensible heat
8. During the sensible heating process only, which of the psychrometric property remain constant?
  - a) Specific humidity
9. During the latent heat addition process only, which of the psychrometric property remain constant?
  - b) DBT
10. On increasing the temperature of atmospheric air, the relative humidity will be-.
  - a) Increasing

**Section – B**

04X04 = 16 Marks

1. Why do we use refrigerant in refrigeration system? How it works in the cycle?

Ans:



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**Answer:** Refrigerant- A heat carrier substance.

For working – It undergoes phase changes at suitable pressure and temperature.

2. Write down the definition of the following:

A. DBT    B. Specific Volume    C. Specific Humidity    D. Relative Humidity

**ANSWER:** A. DBT: The dry-bulb temperature (DBT) is the temperature of air measured by a thermometer freely exposed to the air, but shielded from radiation and moisture. DBT is the temperature that is usually thought of as air temperature.

B. Specific Volume: The *specific volume* of a substance is an intrinsic property of a substance, defined as the ratio of the substance's *volume* (V) to its mass (m). It is the reciprocal of density. *Specific volume* is defined as the number of cubic meters occupied by one kilogram of a particular substance.

C. Specific Humidity : Specific humidity, mass of water vapour in a unit mass of moist air, usually expressed as grams of vapour per kilogram of air, or, in air conditioning, as grains per pound.

D. Relative Humidity: *Relative humidity* also measures water vapor but *relative* to the temperature of the air. It is expressed as the amount of water vapor in the air as a percentage of the total amount that could be held at its current temperature.

3. What is sensible heat factor and what does it represent on psychrometric chart?

Ans:

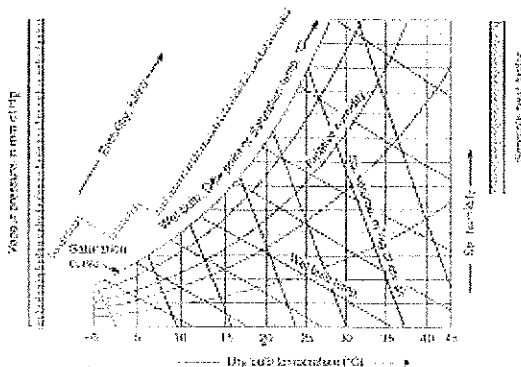
Ans:-

$$SHF = SH / TH$$

SHF= sensible heat factor

SH= sensible heat

TH= Total heat



4. Write short notes on the selection of a refrigerant for a refrigeration system.

Ans:



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Selection criteria (sometimes referred to as award criteria or evaluation criteria) are lists of items against which a prospective supplier can be assessed before a selection is made and a contract awarded. They might also be used to help identify suitable individuals when seeking new employees. Defining specific selection criteria can help an employer agree among themselves the characteristics that they value. This helps ensure they identify the best value submission, rather than simply the lowest price submission. When the employer is evaluating submissions, referring to the selection criteria, or perhaps even giving marks against each criteria can help focus the assessment and prevent it being dominated by personal preferences or by forceful individuals. Informing applicants what the selection criteria are can create a fairer process, enabling applicants to consider in advance whether they are suitable, and helping them tailor their submissions. It also makes the application process more transparent and so less open to challenge. Assessment criteria will vary significantly depending on the nature of the role; whether it is for a consultant, contractor, other supplier or employee, however, some typical criteria might include:

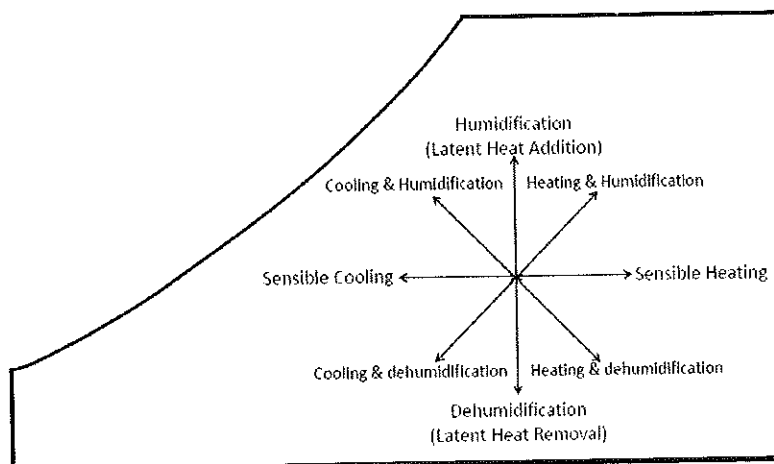
- Price.
- Relevant experience.
- Understanding of the requirements.
- Past performance.
- Technical skills.
- Availability.
- Management skills.
- Proposed methodology.
- Compliance with the requirements of the submission process.
- Financial standing.

## Section – C

04X06 = 24 Marks

1. Explain different air conditioning processes with the help of Psychrometric chart.

Ans:



2. explain the concept of RSHF, GSHF and ERSHF.



It is defined as the ratio of room sensible heat to room total heat. The supply air having conditions given by any point on this line will satisfy requirements of the room with quantity of air supplied different for different points

$$RSHF = RSH / (RSH + RLH)$$

## GSHF

It is defined as ratio of total sensible heat to the grand total heat which the cooling coil is required to handle after the outside fresh air and recirculated air mixing has taken place.  $GSHF = (RSH + \text{Outside air sensible heat}) / ((RSH + \text{outside air sensible heat}) + (RLH + \text{outside air latent heat}))$  The BPF fraction of outside air adds SH load and LH load to the room. However, BPF fraction of return air has no effect as it is already at room condition.

## ERSHF

Effective room sensible heat load (ERSH) =  $RSH + BPF \times \text{outside air SH}$

Effective room latent heat load (ERLH) =  $RLH + BPF \times \text{outside air LH}$

Hence,  $ERSHF = ERSH / (ERSH + ERLH)$

3. A sample of air has DBT  $35^\circ$  and WBT  $25^\circ\text{C}$ . The barometric pressure is 760 mm Hg. Calculate without using psychrometric chart

- Humidity Ratio
- RH
- Enthalpy of sample

Ans:-

Use the carrier equation, find vapor partial pressure = 2.5 KPa

Now

Humidity Ratio = 15 g/Kg of dry air

Relative humidity = 44%

Enthalpy = 75.8 KJ/Kg

4. In a cooling application, moist air enters a refrigeration coil at the rate of 100 kg of air  $35^\circ\text{C}$  DBT and 50% RH. The ADP of the coil is  $5^\circ\text{C}$  and the bypass factor is 0.15. Determine the outlet state of moist air and cooling capacity of coil in TR.

Ans:

Mass flow rate = 100 kg of dry air/min

ADP =  $10^\circ\text{C}$ , BPF = 0.15

$T_2 = 9.5^\circ\text{C}$

a.  $9.5^\circ\text{C}$  DBT,  $9.2^\circ\text{C}$  CWBT.

b. Cooling capacity of the coil =  $m(h_1 - h_2)$

$$\begin{aligned} & 100 \times (81 - 27.5) / 60 \\ & = 89.1 \text{ KW} = 25.33 \text{ TR.} \end{aligned}$$

*Handwritten signature and initials.*



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Course Code: HVA1301

Time: 2 Hours

Course Name: Refrigerant & psychrometry

Max. Marks: 50

SET-B

**Instruction:**

All questions are compulsory.

Section A is objective type.

Section B is short answer type.

Section C is long answer type.

Use psychrometric chart as per requirement.

**Section – A**

10X01 = 10 Marks

1. What is the chemical name of R12?  
a)  $\text{CCl}_3\text{F}$                       b)  $\text{C}_2\text{H}_5\text{F}$                       c)  $\text{CCl}_2\text{F}_2$                       d) None
2. What is the chemical name of R21?  
a)  $\text{CHCl}_2\text{F}$                       b)  $\text{C}_2\text{H}_5\text{F}$                       c)  $\text{CCl}_2\text{F}_2$                       d) None
3. What is the mathematical representation for the refrigerant "Methylchloride"?  
a) R12                              b) R40                              c) R22                              d) None
4. What is the mathematical representation for the refrigerant  $\text{CCl}_3\text{F}$ ?  
a) R12                              b) R40                              c) R22                              d) None
5. What is the mathematical representation for the refrigerant  $\text{C}_2\text{H}_5\text{F}$ ?  
a) R134a                              b) R152                              c) R22                              d) None
6. Which refrigerant is better in view of GWP?  
a) R134a                              b) R152                              c)  $\text{CO}_2$                               d) None
7. The rate of body heat loss is affected by-  
a) Air Temperature                      b) Air humidity  
c) Clothing                              d) All of the above
8. The relative humidity in winter is ----- than in summer season.  
a) Less                                      b) More  
c) Equal                                      d) All of the above
9. What is the unit of gas constant (R) ?  
a) J/Kg-K                                      b) Kg/K-mol  
c) J/Kg                                      d) None
10. What is the measuring unit of relative humidity?  
a) g/Kg of dry air                              b)  $\text{g/m}^3$  of dry air  
c) J/Kg                                      d) None



**Section – B**

04X04 = 16 Marks

1. What is a refrigerant? Write down the classification of refrigerants.
2. What is an azeotrope? Give example to indicate its importance.
3. What is the process used for low RH requirement in a room? Describe the same.
4. Write short notes on the selection of a refrigerant for a refrigeration system.

**Section – C**

04X06 = 24 Marks

1. How is winter air conditioning carried out?
2. Explain the concept of RSHF, GSHF and ERSHF.
3. Describe the classification of refrigerant.
4. In an auditorium which is to be maintained at a temperature not exceeding  $24^{\circ}\text{C}$  and a RH not more than 60%, a sensible heat load of 132 kW and 84 kg/h of moisture has to be removed. Air is supplied to the auditorium at  $15^{\circ}\text{C}$ .
  - a) How many kg of air per hour must be supplied?
  - b) What is the dew point temperature of supply air and is its relative humidity?

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**Session: 2020-21(Summer Semester)**

**B. Voc. Program, III Semester,**

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**ANSWER KEY-B**

**Course Code: HVA1301**

**Course Name: Refrigerant & psychrometry**

**Time: 2 Hours**

**Max. Marks: 50**

**Instruction:**

All questions are compulsory.

Section A is objective type.

Section B is short answer type.

Section C is long answer type.

**Section – A**

10X01 = 10 Marks

1. What is the chemical name of R12?  
c)  $\text{CCl}_2\text{F}_2$
2. What is the chemical name of R21?  
a)  $\text{CHCl}_2\text{F}$
3. What is the mathematical representation for the refrigerant "Methylchloride"?  
b) R40
4. What is the mathematical representation for the refrigerant  $\text{CCl}_3\text{F}$ ?  
a) R11
3. What is the mathematical representation for the refrigerant  $\text{C}_2\text{H}_5\text{F}$ ?  
b) R152
6. Which refrigerant is better in view of GWP?  
c)  $\text{CO}_2$
7. The rate of body heat loss is affected by-  
d) All of the above
8. The relative humidity in winter is ----- than in summer season.  
a) Less
9. What is the unit of gas constant (R)?  
a) J/Kg-K
10. What is the measuring unit of relative humidity?  
d) None



## Section – B

04X04 = 16 Marks

1. What is a refrigerant? Write down the classification of refrigerants.

The working substance that flows through a refrigerator and is capable of absorbing heat from the source (which is at a lower temperature) and dissipate the same to the sink (which is a higher temperature than the source) either in the form of sensible heat (as in case of air refrigeration) or in the form of latent heat (as in the case of vapor Refrigeration) is called a refrigerant.

### CLASSIFICATION OF REFRIGERANTS

- Primary refrigerants (Refrigerants that directly take part in the refrigeration process)
- Secondary refrigerants (refrigerants that are first cooled by the primary refrigerants and then further used for cooling purpose)

#### Classification of primary refrigerants

Halocarbon compounds :

(a) invented and developed by Mr. Charles. Kettering and Dr. Thomas Migley in the year 1928.

(b) Sold in the market under the trade name as "Freon" and contain one or more of three halogens chlorine, fluorine and bromine.

Azeotropes :

Consists of mixtures of different refrigerants which don't separate into their compounds with the change in pressure or temperature or both. They have fixed thermodynamic properties.

Azeotropic mixture is a mixture of two or more liquids which, when mixed in precise proportion, form a compound having a boiling temperature which is independent of the boiling temperature of the individual liquids.

Hydrocarbons:

Most of the organic compounds are considered as refrigerant under this group. Most of them possess satisfactory thermodynamic-properties but are highly flammable.

Inorganic compounds:

The refrigerants under this group were universally used for all purposes before the introduction of halo-carbon. refrigerants. Earlier they were used for different purposes due to their inherent thermo-dynamic and physical properties, for example: Unsaturated Organic Compounds : Comprising of mainly hydrocarbon group with ethylene and propylene bases.

2. What is an azeotrope? Give example to indicate its importance.

An azeotrope or a constant boiling point mixture is a mixture of two or more liquids whose proportions cannot be altered or changed by simple distillation.<sup>[2]</sup> This happens because when an azeotrope is boiled, the vapour has the same proportions of constituents as the unboiled mixture. Because their composition is unchanged by distillation, azeotropes are also called (especially in older texts) constant boiling point mixtures. Many azeotropic mixtures of pairs of compounds are known,<sup>[3]</sup> and many azeotropes of three or more compounds are also known.<sup>[4]</sup> In such a case it is not possible to separate the components by fractional distillation. There are two types of azeotropes: minimum boiling azeotrope and maximum boiling



azeotrope. A solution that shows greater positive deviation from Raoult's law forms a minimum boiling azeotrope at a specific composition.

### 3. What is the process used for low RH requirement in a room? Describe the same.

In our everyday lives the humidity of the air around us very rarely merits discussion unless we are relaxing in a sauna or holidaying near the equator. However, there are not many occasions where humidity is more of an issue than during the processing of textiles. Get it wrong and it can stop production, damage machinery and harm staff. Get it right and you can maximise product weights, improve quality and increase machine speeds. Air humidity is measured as "relative humidity". It is defined as the amount of water in a sample of air compared to the maximum amount of water the air can hold at the same specific temperature. It's expressed in a form of 0 to 100%. Cold air can hold less moisture than warm air therefore the humidity of air is "relative" to its temperature. For example, a sample of air at 10°C can hold less moisture than the same sample of air at 20°C. Even with the same amount of water present in both samples, the warmer sample has a lower relative humidity as it can potentially hold more moisture than the cold air sample. This means that even in humid climates, the indoor air humidity can be low when cool humid air from outside enters a textile production facility and its temperature rises. An increase in temperature of 20°C can lead to a typical drop in humidity of around 60%rH (relative humidity). This means that humid air entering a building at 80%rH would decrease to just 20%rH when heated. This can cause major problems for textile production.

#### Why humidify?

All textiles are hygroscopic. That is, they absorb or release moisture depending on the relative humidity of the surrounding air. If the atmosphere is drier than the textile's equilibrium relative humidity then the textile will give up its moisture to the air. If the air is very humid then the textile's moisture content will increase. This moisture loss and gain occurs at every stage from the initial processing of the fibres through to final garment manufacturing, distribution and use by the consumer. This change in moisture content has a direct impact on the properties of textiles, such as tensile strength, elasticity, fibre diameter and friction. A drop in the equilibrium relative humidity of a textile may cause it to be weaker, thinner, less elastic and therefore more brittle. It will also have more imperfections. By maintaining the air humidity whilst processing the fibres, this loss in moisture to the atmosphere is minimised. Moisture loss during processing cannot be totally eliminated as the act of processing will increase the temperature of the material, which will cause it to become drier. However, by increasing the humidity of the air surrounding the textile directly after processing, the material experiences "regain". Moisture is reabsorbed by the textile, thus improving the quality and performance of the fabric. This regain also has a direct impact on the weight of the textile. As textile yarns are sold by weight, if a drop in humidity leads to a 4% reduction in weight, this will require 4% more fibre to be included in the sale product. For a mill manufacturing 80 tonnes of textile per day, this can lead to a loss of 3,200kg of product per day due to incorrect humidity control.

#### Static

The occurrence of static can be a major problem when processing textiles and it is directly related to levels of relative humidity. The electrical sensitivity that determines whether static electrification will occur is dependent on the moisture content of the air and fibres. As the fibres lose moisture, they increase their electrical resistance. This means they can no longer easily dissipate the electrical charge which is generated by the frictional contact with the machinery.



In a textile production facility with a low humidity, static discharges can jump up to 4-5 inches and, although they have a low current, can build up to several hundred thousand volts. This presents a danger to staff working with the machines as it is not only very uncomfortable if they are shocked, but it can cause a person to jump and fall, which presents extreme risks when working near to textile machinery. The static discharge can also present a direct health risk to people with weak hearts or pace makers fitted. As well as the physical danger to staff, static electrical build-up will cause materials to stick together and be less manageable. This in turn will slow machinery, directly effecting production schedules. Also, as most machines are now microprocessor controlled, an uncontrolled electrical discharge in the wrong place can damage the electronics of the unit resulting in expensive repair bills and significant downtime. By maintaining humidity at around 50%RH, static build-up is eliminated and all these associated problems are avoided. Another advantage of maintaining the correct humidity in processing facilities is that it reduces airborne particles. A higher humidity encourages airborne lint, dust and fly to precipitate out of the atmosphere. Also, if a cold water humidification system is used, the evaporation of the water into the air causes an adiabatic cooling effect that can reduce ambient temperatures by between 2-6°C. These additional benefits of using humidifiers create a healthier, less polluted, more pleasant atmosphere for workers and a more productive workforce.

## Humidity levels

So what is the ideal humidity? Well this depends on the type of textile and the process being undertaken. Natural fibres are far more susceptible to moisture than manmade, in terms of performance. However manmade textiles suffer more with static charge build up. Cotton and linen have to be processed at very high levels, around 70-80%RH, because they are very brittle. By humidifying each process, from the combing of the raw material, through carding, twisting, spinning and weaving, the manufacturer can ensure that the product remains flexible and is prevented from breaking. This is important since the longer the fibre, the finer the thread that can be spun from it. Wool is similarly susceptible to dry air, although a little more forgiving, requiring humidity levels of around 65%RH. Man-made fibres also require the correct, albeit lower, level of humidity since below 45%RH they are prone to a build-up of static electricity. Silk should be processed at between 65-70%RH, although artificial silk spinning requires a higher level of 85%RH.

## 4. Write short notes on the selection of a refrigerant for a refrigeration system.

Selection criteria (sometimes referred to as award criteria or evaluation criteria) are lists of items against which a prospective supplier can be assessed before a selection is made and a contract awarded. They might also be used to help identify suitable individuals when seeking new employees. Defining specific selection criteria can help an employer agree among themselves the characteristics that they value. This helps ensure they identify the best value submission, rather than simply the lowest price submission. When the employer is evaluating submissions, referring to the selection criteria, or perhaps even giving marks against each criteria can help focus the assessment and prevent it being dominated by personal preferences or by forceful individuals. Informing applicants what the selection criteria are can create a fairer process, enabling applicants to consider in advance whether



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they are suitable, and helping them tailor their submissions. It also makes the application process more transparent and so less open to challenge. Assessment criteria will vary significantly depending on the nature of the role; whether it is for a consultant, contractor, other supplier or employee, however, some typical criteria might include:

- Price.
- Relevant experience.
- Understanding of the requirements.
- Past performance.
- Technical skills.
- Availability.
- Management skills.
- Proposed methodology.
- Compliance with the requirements of the submission process.
- Financial standing.

## Section – C

04X06 = 24 Marks

1. how is winter air conditioning carried out?

**Air Conditioning System Winter Air Conditioning System** In winter air conditioning, the air is heated which is generally followed by humidification. The schematic arrangement of the system is shown in Fig. The outside air flows through a damper and mixes up with the re-circulated air (which is obtained from the conditioned space). The mixed air passes through a filter to remove dirt, dust and other impurities. The air now passes through a preheat coil in order to prevent the possible freezing of water and to control the evaporation of water in the humidifier. After that, the air is made to pass through a reheat coil to bring the air to the designed dry bulb temperature. Now, the conditioned air is supplied to the conditioned space by a fan. From the conditioned space, a part of the used air is exhausted to the atmosphere by the exhaust fans or ventilators. The remaining part of the used air (Known as re-circulated air) is again conditioned as shown in Fig. The outside air is sucked and made to mix with re-circulated air, in order to make up for the loss of conditioned (or used) air through exhaust fans or ventilation from the conditioned space.

**Summer Air Conditioning System** It is the most important type of air conditioning, in which the air is cooled and

2. explain the concept of RSHF, GSHF and ERSHF.

### **RSHF**

It is defined as the ratio of room sensible heat to room total heat. The supply air having conditions given by any point on this line will satisfy requirements of the room with quantity of air supplied different for different points

$$\text{RSHF} = \text{RSH} / \text{RSH} + \text{RLH}$$

### **GSHF**



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It is defined as ratio of total sensible heat to the grand total heat which the cooling coil is required to handle after the outside fresh air and recirculated air mixing has taken place.  
 $GSHF = \frac{\text{Room sensible heat} + \text{Outside air sensible heat}}{\text{Room sensible heat} + \text{Outside air sensible heat} + \text{RLH} + \text{outside air latent heat}}$   
 The BPF fraction of outside air adds SH load and LH load to the room. However BPF fraction of return air has no effect as it is already at room condition. Thus,

Effective room sensible heat load (ERSH) = RSH + BPF x outside air SH

Effective room latent heat load (ERLH) = RLH + BPF x outside air LH

Hence,  $ERSHF = \frac{ERSH}{ERSH + ERLH}$

3. Describe the classification of refrigerant.

Chlorofluorocarbons (CFCs)

Hydrochlorofluorocarbons (HCFCs)

Hydrofluorocarbons (HFCs)

Hydrocarbons (HCs)

4. In an auditorium which is to be maintained at a temperature not exceeding 24° C and a RH not more than 60%, a sensible heat load of 132 kW and 84 kg/h of moisture has to be removed. Air is supplied to the auditorium at 15° C.

a) How many kg of air per hour must be supplied?

b) What is the dew point temperature of supply air and is its relative humidity?

Ans: RLCL =  $84 \times 2444.9 / 3600 = 57 \text{ kw}$ . ( hfg at 24° C = 2444.9 KJ/kg)

$RSHF = 132 / (132 + 57) = 0.6982$

$RTCL = m(h_r - h_s)$

a. mass of air per hour that must be supplied  $m_a = RTCL / (h_r - h_s)$

$189 / (52.7 - 39.7) = 14.54 \text{ kg/s}$

$= 52.39 \times 10^3 \text{ kg/h}$

b. supply air condition is 15° C as given. From psychrometric chart RH = 92%.

DPT is 13.7° C.

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Registration No.: .....

School of RAC Skills  
Session: 2020-21 (Summer Semester)  
B. Voc. Program 3<sup>rd</sup> Semester,  
End-Sem. Examination

Course Code: HVA1302

Time: 2 Hours

Course Name: Compressor Condenser and Evaporator

Max. Marks: 50

Instruction: In section A, Write options as well as answer

Set-A  
Section – A

10X01 = 10 Marks

- Which oil is most suited with R134a?  
(a) PAG (b) Mineral oil (c) Ab (d) POE
- What is main function of compressor?  
(a) Increase Pressure (b) Convert liquid into gas (c) Exchange heat (d) None of them
- What is the main function of evaporator?  
(a) Increase pressure (b) Heat Exchange (c) Condense the vapour (d) None of them
- Diaphragm type compressor is a type of?  
(a) Reciprocating Compressor (b) Rotary Compressor (c) Axial Compressor (d) Centrifugal
- Plate in tube type heat exchange is a type of?  
(a) Compressor (b) Condenser (c) evaporator (d) Both compressor and evaporator
- Which oil is suitable with R22?  
(a) PAG (b) Mineral oil (c) Ab (d) POE
- What is main function of condenser?  
(a) Increase temperature (b) Convert vapour into liquid  
(b) (c) Increase pressure (d) None of them
- What is the cooling medium in Evaporative condensers?  
(a) Water (b) Air (c) Water and air both (d) None of them
- Which type of compressor is commonly used in low cooling capacity domestic refrigerators?  
(a) Fin and Tube (b) Coil In tube (c) Wire and tube (d) Shell and tube
- Fin in tube type heat exchange is a type of?  
(a) Compressor (b) Condenser (c) Expansion Valve (d) Both compressor and evaporator

Section – B

04X04 = 16 Marks

- Write a short note on rotary vane compressor?
- What are differences between condenser and evaporator?



3. How reciprocating compressor work?
4. What is the double tube condenser?

Section – C

04X06 = 24 Marks

1. What are different types of evaporators, explain working with diagram.
2. Write a short note on types of condenser.
3. How does compressor work, explain in details?
4. Write a short note on P-H chart.

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# BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills  
Session: 2020-21 (Summer Semester)  
B. Voc. Program 3<sup>rd</sup> Semester,  
End-Sem. Examination

Course Code: HVA1302

Course Name: Compressor Condenser and Evaporator

Instruction: In section A, Write options as well as answer

Time: 2 Hours

Max. Marks: 50

Set-A  
Section – A

*Answer key*

10X01 = 10 Marks

1. Which oil is most suited with R134a?  
(d) POE
2. What is main function of compressor?  
(a) Increase Pressure
3. What is the main function of evaporator?  
(b) Heat Exchange
4. Diaphragm type compressor is a type of?  
(a) Reciprocating Compressor
5. Plate in tube type heat exchange is a type of?  
(c) evaporator
6. Which oil is suitable with R22  
(b) Mineral oil
7. What is main function of condenser?  
(b) Convert vapor into liquid
8. What is the cooling medium in Evaporative condensers?  
(c) Water and air both
9. Which type of compressor is commonly used in low cooling capacity domestic refrigerators?  
(c) Wire and tube
10. Fin in tube type heat exchange is a type of?  
(a) Compressor (b) Condenser (c) expansion Valve (d) Both compressor and evaporator

Section – B

04X04 = 16 Marks

1. Write a short note on rotary vane compressor?

Answer



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This system uses a set of vanes that are slightly offset within the inner chamber. As air comes in through the inlet, rotating vanes push the air along into a tighter and tighter edge of the circle, effectively compressing it while using minimal effort and travel of the air itself. These are very simple compressors that are easy to maintain as well, but vanes wear down over time and can become less effective at forcing the air into the compressed space. In many cases, replacement vanes are available to restore the compressor to its original operating tolerances every few years.

## 2. What are differences between condenser and evaporator?

**Answer:**

1. Condenser is also known as cooling coil where as the evaporator also known as cooling coil.
2. Condenser rejects cooling system into atmosphere on the other hand evaporator absorb heat of room.

## 3. How reciprocating compressor work?

**Answer:**

Reciprocating compressors work to transport natural gas from the suction manifold and into the natural gas cylinder, which is also referred to as the compression cylinder. An internal combustion engine powers this entire process. When the compressor's operating life increases, then the packing systems and rings will wear out resulting in higher leaks. Therefore, high quality components and expert installation are the key to ensuring balance in this essential system.

### Section – C

04X06 = 24 Marks

## 1. What are different types of evaporators, explain working with diagram.

**Answer:**

### • Bare Tube Evaporators

The bare tube evaporator comprises of several turns of the tubing, though most commonly flat zigzag and oval trombone are the most common shapes. The bare tube evaporators are usually used for liquid chilling. In the blast cooling and the freezing operations the atmospheric air flows over the bare tube evaporator and the chilled air leaving it used for the cooling purposes. The bare tube evaporators are used in very few applications, however the bare tube evaporators fitted with the fins, called as finned evaporators are used very commonly.



- Tube and Plate Type Evaporators

In the plate type of evaporators the coil usually made up of copper or aluminum is embedded in the plate so as to form a flat looking surface. Externally the plate type of evaporator looks like a single plate, but inside it there are several turns of the metal tubing through which the refrigerant flows. The advantage of the plate type of evaporators is that they are more rigid as the external plate provides lots of safety.

- Finned Evaporators

The finned evaporators are the bare tube type of evaporators covered with the fins. When the fluid (air or water) to be chilled flows over the bare tube evaporator lots of cooling effect from the refrigerant goes wasted since there is less surface for the transfer of heat from the fluid to the refrigerant. The fins on the external surface of the bare tube evaporators increases the contact surface of the of the metallic tubing with the fluid and increase the heat transfer rate, thus the finned evaporators are more effective than the bare tube evaporators.

- Shell and Tube types of Evaporators

The shell and tube types of evaporators are used in the large refrigeration and central air conditioning systems. The evaporators in these systems are commonly known as the chillers. The chillers comprise of large number of the tubes that are inserted inside the drum or the shell. Depending on the direction of the flow of the refrigerant in the shell and tube type of chillers, they are classified into two types: dry expansion type and flooded type of chillers.

## 2. Write a short note on types of condenser.

### Answer

Types of Condenser: There are three types of condensers commonly used in vapour compression refrigeration system.

1. Air cooled condenser
2. water cooled condenser
3. Evaporative condenser

- *Air Cooled Condenser:* The atmospheric air is used as a medium of heat transfer in air cooled condenser. The heat rejected by the refrigerant is received by the air. The air circulation over an air cooled condenser may be either natural convection or by the action of blower or fan. Accordingly, they are classified as natural draft or mechanical



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draft condenser. The air cooled condenser consists of finned tubing of copper or other suitable metal in which the vapour of the refrigerant enters from the top and the liquid refrigerant leaves from the bottom of the condenser.

- *Water cooled condensers:* In water cooled condenser, heat is rejected in the water which in turn is cooled in the cooling tower and the same water is circulated in the water cooled condenser. Based on the construction, water cooled condensers are of three types viz. shell and tube type, double pipe and shell and coil type.
- *Evaporative condenser:* The evaporative condenser uses both, water and air for the condensation of the refrigerant. The evaporative condenser consists of a coil in which the refrigerant is flowing and condensing inside and its outer surface is wetted with water and exposed to a stream of air to which heat is rejected principally by evaporation of water. The water is sprayed over the pipes carrying hot refrigerant vapour and movement of air over the wet tubes creates evaporation of water resulting into cooling of the refrigerant. The heat lost from the refrigerant is carried by the air-water mixture leaving the condenser. These types of condensers are mainly classified in two groups.
  1. Natural draft evaporative condenser
  2. Mechanical draft evaporative condenser

### **3. How does screw and rotary-vane compressors work, briefly?**

#### **Answer**

- *The Rotary-Vane Compressor:* The vane splits the cylinder into suction and discharge sections. The pistons rotate to increase and decrease the volumes of the sections. Continuous rotation achieves gas suction, compression, and discharge.

The operation of a rotary vane compressor includes five actions. These actions are; start, suction, compression, discharge then end. Each crankshaft rotation achieves all these five actions.
- *The Rotary-Screw Compressor:* This compressor uses helical screw rotors to compress larger volumes of refrigerant. The compression involves the motor and the male and female rotors. The motor rotates the male rotor through the crankshaft. The male rotor moves the female rotor as the rotors inter-mesh against each other.

The meshing rotors force the refrigerant through the suction port of the compressor. The compressed refrigerant leaves via the discharge port at a higher pressure.



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The screw compressor competes with large reciprocation and small centrifugal compressors. You find rotary screw compressors in commercial and industrial refrigeration and air-conditioning systems.

## 4. Write a short note on P-H chart.

Answer: -

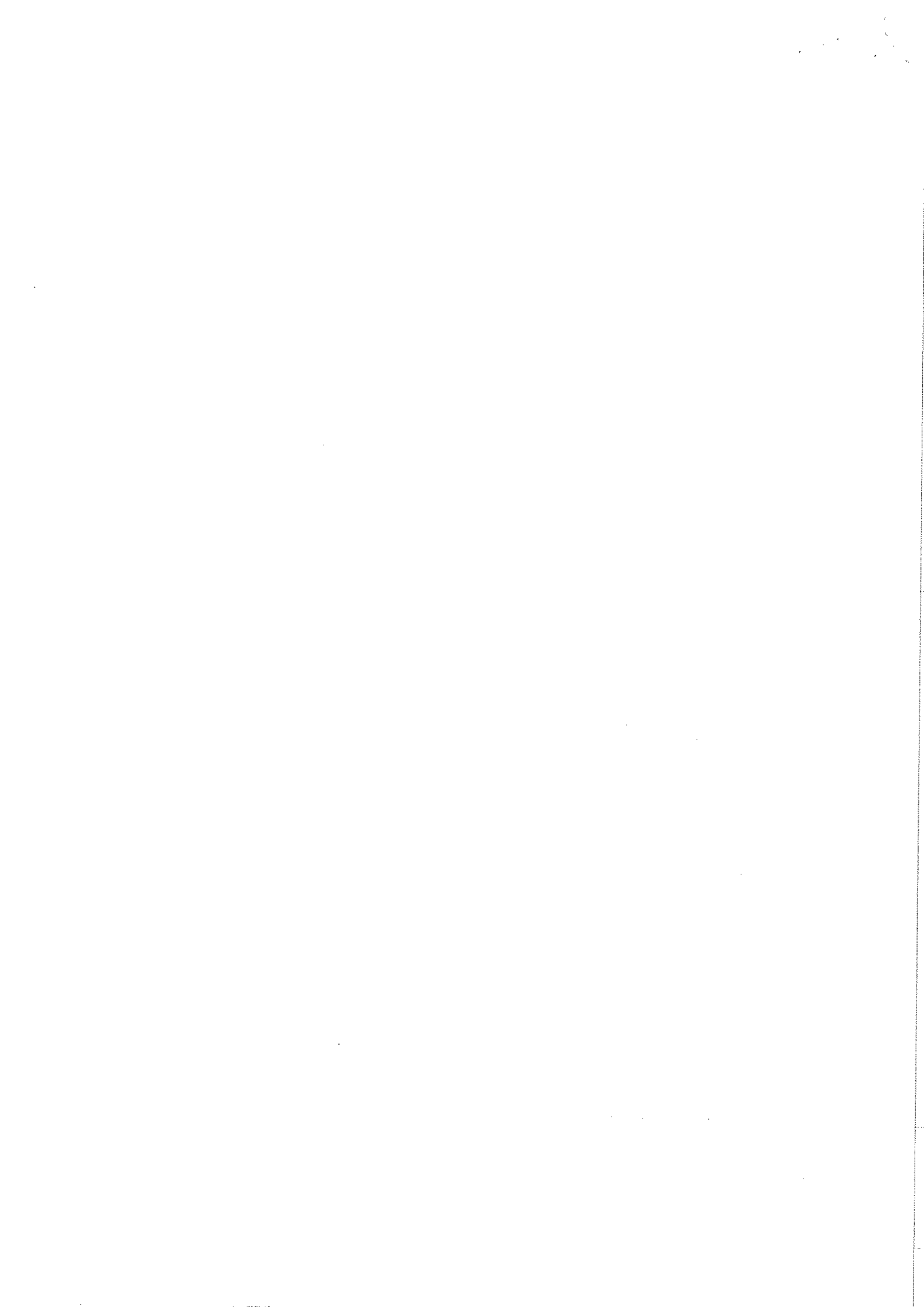
- On the P-H diagram, pressure is indicated on the y-axis and enthalpy is indicated on the x-axis.
- Typically enthalpy is in units of Btu/lb and pressure is in units of pounds per square inch (psi).
- The upside down U figure shown on the diagram designates the points at which the refrigerant changes phase.
- The left vertical curve indicates the saturated liquid curve and the right vertical curve indicates the saturated vapor curve.
- The region in between the two curves describe refrigerant states that contain a mixture of both liquid and vapor.
- The locations to the left of the saturated liquid curve indicate that the refrigerant is in liquid form and locations to the right of the saturated vapor curve indicate that the refrigerant is in vapor form.
- The point at which the two curves meet is called the critical point. The importance of this point is that at any point above, no additional pressure will change the vapor into a liquid.

1) Liquid Region: The liquid region is also known as the subcooled region. In this region there are vertical temperature lines, which increase as enthalpy is increased. Figure 8 is a simplified P-H diagram illustrating the constant temperature lines.

(2) Vapor Region: The vapor region is also known as the superheated region. In this region there are vertical temperature lines, which increase as enthalpy is increased. Refer to Figure 8. There are also lines of constant entropy, which are also important. Entropy is the measure of the amount of disorder in the system.

(3) Liquid-Vapor Mix Region: In this region, the P-H diagram shows horizontal temperature lines, which indicate constant temperature. In this reason liquid and vapour both present according to the temperature and pressure.

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# BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills

Session: 2020-21 (Summer Semester)

B. Voc. Program 3<sup>rd</sup> Semester,

End-Sem. Examination

Course Code: HVA1302

Course Name: Compressor Condenser and Evaporator

Instruction: In section A, Write options as well as answer

Time: 2 Hours

Max. Marks: 50

~~Set-B~~  
Set-B  
Section - A

10X01 = 10 Marks

1. Which of the following is not related to the p-h chart?

- a) Triple point (b) Critical point  
(c) Temperature Lines (d) Specific Volume lines

2. Which process is related to the expansion valve?

- a) Isothermal heat rejection (b) Isobaric refrigerant expansion  
c) Isenthalpic cooling (d) Isenthalpic expansion

3. Which compressor normally has suction and discharge valves?

- a) Rotary Compressor (b) Screw Compressor  
(c) Single acting Compressor (d) Centrifugal Compressor

4. Which component of the VCR system works according to the (P-H Chart) following equation?

$$Q = m \times (h_2 - h_3)$$

- a) Compressor (b) Condenser  
c) Evaporator (d) Expansion Valve

5. One Air conditioner system extracts heat from 20°C and rejects it in ambient (40 °C), what will be the Carnot COP of the system?

- a) 12.65 (b) 13.65 (c) 14.65 (d) 15.65

6. In the p-h chart, what represents "saturated liquid"?

- a) Liquid at its boiling temperature (b) Liquid at its critical temperature  
c) Liquid at its critical pressure (d) Liquid below boiling point



7. Which process is related to the Compressor?

- a) Isenthalpic compression
- b) Isobaric refrigerant compression
- c) Isentropic compression.
- d) Isenthalpic expansion

8. Which compressor consists of "vane" to function properly?

- a) Centrifugal compressor
- b) Screw Compressor
- c) Single acting compressor
- d) Rotary compressor

9. Which component of the VCR system works according to the following equation

$$Q = m \times (h_2 - h_1)$$

- a) Evaporator
- b) Compressor
- c) Condenser
- d) Expansion Valve

10. What is the unit of enthalpy?

- a) KJ/ Kg. K
- b) Kg/ KJ. C
- c) KJ/ Kg
- d) KJ/ Kg. C

**Section – B**

04X04 = 16 Marks

1. Write a short note on the scroll refrigerant compressor.
2. Explain the working of an evaporator with a suitable sketch.
3. Explain working of Condenser, explain with neat sketch.
4. Write a short note on lubricating oils used in refrigerant compressors.

**Section – C**

04X06 = 24 Marks

1. Explain following types of cooling tower: -
  - (a) Capacity of CT
  - (b) Range of CT
2. What are different types of lines in PH chart?
3. Write the advantages of different types of rotary-compressor?
4. Write at least three applications of each types of evaporators?

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School of RAC Skills  
Session: 2020-21 (Summer Semester)  
B. Voc. Program 3<sup>rd</sup> Semester,  
End-Sem. Examination

Course Code: HVA1302

Time: 2 Hours

Course Name: Compressor Condenser and Evaporator

Max. Marks: 50

Instruction: In section A, Write options as well as answer

~~Set-B~~ Answer Key  
Section – A

10X01 = 10 Marks

1. Which of the following is not related to the p-h chart?

a) Triple point

2. Which process is related to the expansion valve?

(d) Isenthalpic expansion

3. Which compressor normally has suction and discharge valves?

(c) Single acting Compressor

4. Which component of the VCR system works according to the (P-H Chart) following equation?

$$Q = m \times (h_2 - h_3)$$

(b) Condenser

5. One Air conditioner system extracts heat from 20°C and rejects it in ambient (40 °C), what will be the Carnot COP of the system?

a) 12.65

b) 13.65

c) 14.65

d) 15.65

6. In the p-h chart, what represent “saturated liquid”?

a) Liquid at its boiling temperature

7. Which process is related to the Compressor?

c) Isentropic compression.

8. Which compressor consists of “vane” to function properly?

d) Rotary compressor



9. Which component of the VCR system works according to the following equation

$$Q = m \times (h_2 - h_1)$$

b) Compressor

10. What is the unit of enthalpy?

c) KJ/ Kg

## Section – B

04X04 = 16 Marks

1. Write a short note on the scroll refrigerant compressor.

**Answer:**

A scroll compressor has one fixed scroll which remains stationary and another moving or orbiting scroll that rotates through the use of a swing link. When this happens, the pockets of refrigerant between the two scrolls are slowly pushed to the center of the two scrolls, causing the reduction of the volume of the gas. It is then discharged through the center port to the condenser.

2. Explain the working of an evaporator with a suitable sketch.

**Answer:**

The process of heat removal from the substance to be cooled or refrigerated is done in the device known as Evaporator. Evaporator is also known as Boiler, Freezing unit, Low side, cooling coil, chilling unit. Liquid refrigerant at the cooling coil picks up this heat and absorb it so the liquid refrigerant transferred into vapour. The cooling coil, consists at good conductor at heat, permits to rapid heat transfer.

3. Explain working of Condenser, explain with neat sketch.

**Answer:**

Condenser is a heat exchanger in which heat transfer from refrigerant to a cooling medium takes place. The heat from the system is rejected either to atmosphere air or to the water used as cooling medium. The function of the condenser is to convert superheated refrigerant vapour into liquid refrigerant. The cooling medium used may be air, water or combination of air and water depending on the type of condenser employed in the refrigeration system.

4. Write a short note on lubricating oils used in refrigerant compressors.

**Answer:**

Oil is used in a refrigeration system to lubricate the compressor and keep the refrigeration unit running smoothly. Special formulations of oil are required to lubricate the internal



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components of a compressor, adding to the expense of manufacturing and operating cooling equipment while raising environmental issues such as disposal of waste oil and ozone depletion that contributes to global warming.

There are basically 4 types of lubricant, according to refrigerant behavior

- a. POE
- b. PAG
- c. AB
- d. Mineral Oil

## Section – C

04X06 = 24 Marks

**1. Explain following types of cooling tower: -**

**(a) Capacity of CT**

**(b) Range of CT**

**Answer:**

**(a) Capacity of CT**

Heat dissipation (in kCal/hour) and circulated flow rate (m<sup>3</sup>/hr) are an indication of the capacity of cooling towers. However, these design parameters are not sufficient to understand the cooling tower performance. For example, a cooling tower sized to cool 4540 m<sup>3</sup>/hr through a 13.9 °C range might be larger than a cooling tower to cool 4540 m<sup>3</sup>/hr through a 19.5 °C range.

Therefore

other design parameters are also needed.

**(b) Range of CT**

The range is determined not by the cooling tower, but by the process, it is serving. The range at the exchanger is determined entirely by the heat load and the water circulation rate through the exchanger and going to the cooling water. The range is a function of the heat load and the flow circulated through the system:

$$\text{Range } ^\circ\text{C} = \text{Heat load (in kCal/hour)} / \text{Water circulation rate (l/hour)}$$

**2. What are different types of lines in PH chart?**

**Answer:**

- a. Temperature lines: This line travel through the PH graph. Under the dome temperature line shows constant pressure because of latent heat for phase change.
- b. Pressure lines: Y-axis shows pressure axis, These lines are straight lines perpendicular to the pressure axis.
- c. Enthalpy lines: X-axis shows enthalpy axis. These are the straight lines perpendicular to the x-axis.



Entropy lines: We can find entropy lines in superheat region of the graph. These lines are curved lines, start from saturated vapor region and travel to the right side of graph.

d. Specific Volume: - These lines are very thin lines, these lines travel through the graph. These lines start from subcooled and travel towards the super-heated region.

### 3. Write the advantages of different types of rotary-compressor?

**Answer:**

- Vane type Compressor:
  - 1) It creates a good vacuum for suction.
  - 2) Vane Compressor works well for continuous air supplied.
  - 3) High pressure and high power compression are possible with vane compressor.
  - 4) Vane compressors have a longer life expectancy.
  - 5) They are ideally suited for moderate pressure using applications.
  
- Scroll Type compressor:
  1. *DURABILITY*: Scroll compressors don't have as many moving parts as other types of compressors, so breakdowns are less likely. They even work better over time. As the scrolls become worn, they fit together better and keep more air or refrigerant from escaping.
  2. *QUIET OPERATION*: Since scroll compressors have few moving parts, they're much quieter than other heaters and air conditioners. They don't have any noisy valves, and they produce less vibration.
  
- *Screw compressor*:
  1. Safe and Convenient  
Rotary screw air compressors are incredibly convenient, given that they deliver air continuously for the required purposes.
  2. Functions at extreme weather conditions  
Rotary air compressors can work at high temperatures or in low conditions to your convenience.

### 4. Write at least three applications of each types of evaporators?

**Answer:**

- Fin-tube type:
  1. In Air Conditioner:
  2. In Medium and high back pressure refrigerators
  3. In small chillers:



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- Shell and tube
  - (1) Power Generation:
  - (2) HVAC:
  - (3) Marine Applications:
  - (4) Pulp and Paper:
  - (5) Refrigeration:
  - (6) Pharmaceuticals:
  - (7) Air Processing and Compressor Cooling:
  - (8) Metals and Mining:

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**School of RAC Skills**

**Session: 2020-21 (Summer Semester)**

**B. Voc. 3<sup>rd</sup> Semester,**

**End-Sem. Examination**

**Course Code: HVA1303**

**Time: 2 Hours**

**Course Name: Air distribution**

**Max. Marks: 50**

**Instruction: Attempt all questions**

SET-A

**Section – A**

10X01 = 10 Marks

1. What is the value for 22 gauge galvanized steel ?:  
a) 0.022 b) 0.0336 c) 0.5 d) 0.0201
  
2. Each pound of air at standard atm pressure and 70°F can hold :  
a) 110 grains of moisture  
b) 0.01378 pounds of moisture  
c) Both a and b  
d) None of the above
  
3. Air movement above 40 fpm is called –  
a) High terminal air velocity  
b) Drafts  
c) Stratification  
d) None of the above
  
4. Which of the following is an air contaminant?  
a) Asbestos Fibers  
b) Pathogens  
c) CO2  
d) All of the above
  
5. If the RH is Low then the space needs to be \_\_\_\_\_ to provide thermal comfort.  
a) Warmer  
b) Hotter  
c) Cooler  
d) Can't be determined.
  
6. VRV works on:  
a) frequency principle b) amplitude principle c) wavelength principle d) all of the above.
  
7. Duct sizing specifications are generally given for:  
a) Rectangular ducts b) Round ducts c) fiberglass ducts d) oval ducts
  
8. Which of the following causes both sensible and latent heat gain?  
a) walls  
b) glasses  
c) People  
d) Lighting
  
9. Air flow due to change in density and pressure is:  
a) Conduction b) convection c) radiation d) none of the above
  
10. The minimum total supply of airflow for Office applications should be :  
a) 0.05 cfm/ft<sup>2</sup> b) 0.06 cfm/ft<sup>2</sup> c) 0.6 cfm/ft<sup>2</sup> d) 0.12 cfm/ft<sup>2</sup>



**Section – B**

04X04 = 16 Marks

1. What is equal friction method?
2. Explain the process of how VRV works with the help of a flowchart?
3. How to make sure that you're performing accurate heat load study?
4. What are some control devices in an air distribution system?

**Section – C**

04X06 = 24 Marks

1. What are duct leaks? Explain some problems caused by them
2. What is duct sizing? Explain.
3. What are the components of a VRV?
4. What are the factors that affect thermal comfort?

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School of RAC Skills

Session: 2020-21 (Summer / Winter Semester)

B. Voc. 3<sup>rd</sup> Semester,

End-Sem. Examination

Course Code: HVA1303

Time: 2 Hours

Course Name: Air distribution

Max. Marks: 50

Instruction: Attempt all questions

SET-A

*Answer Key*

Section – A

10X01 = 10 Marks

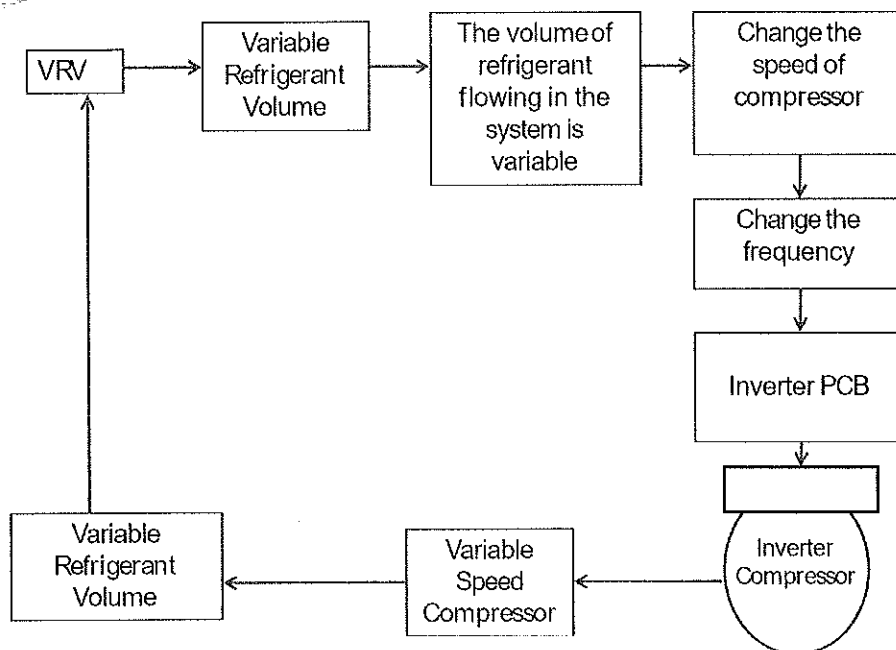
- 1. b
- 2. c
- 3. b
- 4. D
- 5. B
- 6. A
- 7. B
- 8. C
- 9. A
- 10. D

Section – B

04X04 = 16 Marks

1. Equal friction is a method where the friction is used to determine the duct size. Velocity and friction value give the diameter of the round duct which further gives the rectangular duct values.

2.



3. By using correct tables

By using correct factor values

By using correct location information

By using correct cfm calculation method



4. A control is a device that regulates a variable such as temperature, velocity or pressure. Controls may be manual or automatic. For example, an air handling unit might have a manually set minimum flow of outside air and an automatic control to increase the outside air as the building becomes more densely occupied. If automatic, the implication is that the control is responsive to a measured change in pressure, temperature or some other variable to be regulated. Two common and important controls are dampers and thermostats. A damper is a device used to vary the volume of air passing through an outlet, inlet or duct. A thermostat is an automatic device that is responsive to temperature. Thermostats are used to maintain a constant temperature in a regulated space, permit the passage of control air when the temperature of the controlled air is within the limits at which the thermostat is set, and other temperature control purposes.

## Section – C

04X06 = 24 Marks

1. In both new and existing homes, as much as 25% of the total energy losses can often be blamed on air leakage in forced-air duct systems. Testing and sealing leaky air distribution systems is one of the most cost-effective energy improvements for homeowners. Because air is invisible, most duct leaks go unnoticed by HVAC contractors and homeowners. Often, ducts are in attics, crawl spaces, or other hard to-access places. It is usually these hard-to-find-and-access leaky ducts that are the important ones to fix because of their being connected to hot attics or humid crawl spaces. Listed below are a few problems caused by leaky ductwork.:

1. Leaks in return ducts draw air into the building from crawl spaces, garages, and attics, bringing with it dust, mold spores, pollen, insulation fibers, and other contaminants.
2. Leaks in supply ducts cause expensive conditioned air to be dumped directly outside, in the attic or crawl space, rather than delivering it to the building.
3. Duct leakage greatly increases the use of electric strip heaters in heat pumps during the heating season.
4. In humid climates, return-air ducts drawing in moist air leaks can overwhelm air-conditioning humidity loads, causing occupants to feel clammy.
5. Unconditioned air pulled in by leaky return-air ducts will reduce both efficiency and capacity of the air-conditioning system by pulling hot air into the air-conditioning system or cold air into the heating system.

2. The power of an HVAC system may be directly proportional to its size but that does not mean that you will benefit from buying an over-sized HVAC system for your home. HVAC systems need to be adequately sized, depending on the size and area of your house. A unit that is too small for your home will have to run continuously in order to provide you the required amount of conditioned air. This will cause unnecessary wear and tear of the components. A unit too large will keep switching Off and On, putting a load on the compressor and other parts. You will also end up spending too much on your energy bills. It is not only the size of the HVAC unit that matters but also the size of your ductwork. The wrong sized ducts will cause similar problems like those caused by the wrong sized unit, eventually putting too much pressure on your unit. Duct sizing depends on multiple factors like size of your home, air flow velocity, friction loss and static pressure of the HVAC system.



3. VRF systems include two major components, a compressor with outdoor coil and multiple indoor fan coil units. The outdoor unit houses the compressor which acts as a pump pushing refrigerant through piping to the indoor coils and back.

A third component is the VRF Branch Selector Box which is the traffic cop of the refrigerant, based on the demand of the system. See our article on VRF Single Port versus Multiport Branch Selector Boxes. The outdoor coil is most often air cooled, or in some cases water-cooled with a connected cooling tower and boiler to maintain a minimum range of temperature. The compressor provides a variable flow of refrigerant by using an inverter rated motor that varies the speed of the compressor, allowing for reduced energy consumption and varying loads within the building.

## 4. Factors Affecting Heat Exchange

The factors that affect heat exchange from a human body are :

- **Dry bulb/Wet Bulb temperature:** The air dry-bulb temperature is the temperature measured on an ordinary thermometer. Instruments used to measure wet-bulb temperatures are called psychrometers. The wetbulb temperature is measured by placing a wick soaked with water around the thermometer bulb and moving it rapidly through the air. Water evaporates from the wick, cooling the bulb and lowering the temperature. The most common psychrometers are called sling psychrometers because they are swung in circles to help evaporate the water from the wet bulb. The relation of the wet-bulb temperature to the drybulb temperature is a measure of the relative humidity. At 100 percent relative humidity, both the wet-bulb and drybulb temperatures will be the same because water will not evaporate from the wet bulb. However, at lower relative humidity levels, the wet-bulb temperature will be considerably lower than the dry-bulb temperature.
- **Relative Humidity:** Relative humidity compares the amount of water in the air to the amount of water the air can hold at a given temperature. For example, the most water the air can hold at 75°F is 130 grains. A sample of air at 75°F with 65 grains of water is at 50 percent relative humidity because it is holding 50 percent as much water as it can hold at that temperature

*Dr. Anand  
R. Singh*





**School of RAC Skills**

**Session: 2020-21 (Summer Semester)**

**B. Voc. 3<sup>rd</sup> Semester,**

**End-Sem. Examination**

**Course Code: HVA1303**

**Time: 2 Hours**

**Course Name: Air distribution**

**Max. Marks: 50**

**Instruction: Attempt all questions**

**SET-B**

**Section – A**

**10X01 = 10 Marks**

1. Pressure in ductwork is expressed by which of the following units?
  - a) Inches of water column
  - b) Psig
  - c) Psia
  - d) Inches of Hg.
2. Warm air heats a room better if distributed
  - a) low in the room.
  - b) high in the room.
  - c) behind the furniture.
  - d) under the curtains.
3. Which of the following types of fan is used to move large amounts of air against a low static pressure drop?
  - a) Vane axial
  - b) Centrifugal
  - c) Large
  - d) Propeller
4. The duct sizes on the air friction chart are expressed in which of the following?
  - a) Square b) Round c)Oval d)Rectangular
5. Zoning an air-conditioning or heating system allows for
  - a) temperature control of individual rooms or areas in the space.
  - b) simultaneous heating and cooling of individual rooms in a structure.
  - c) Neither A nor B is a characteristic of a zoned system.
  - d) Both A and B are characteristics of a zoned system.
6. The \_\_\_\_\_ is frequently used to measure diffusers and slot air flows.
  - a) anemometer b) pitot tube c) capture hood d) all of the above.
7. Duct sizing and construction specifications are generally stated in terms of the use of \_\_\_\_\_.
  - a) galvanized steel b) aluminum c) fiberglass reinforced plastic d) none of the above.
8. The perception of comfort relates to which of the following?
  - a) individual physical condition
  - b) body heat exchange with the surroundings
  - c) physiological characteristics
  - d) all of the above
9. Air flow above \_\_\_\_\_ fpm is considered not good for human comfort.
  - a) 30 b) 40 c) 60 d) 100
10. The minimum total supply of airflow for residential applications should be :
  - a)0.05 cfm/ft<sup>2</sup> b) 0.06 cfm/ft<sup>2</sup> c)0.6 cfm/ft<sup>2</sup> d)10 cfm



**Section – B**

04X04 = 16 Marks

1. What is indoor air quality?
2. What are some of the materials used in duct construction?
3. Why should all ductwork design should start with accurate heat load study?
4. What is VRV and how does it work?

**Section – C**

04X06 = 24 Marks

1. What is a distribution system selection criterion?
2. What is zoning? Explain.
3. What are the components of an air distribution system?
4. What are the factors that affect heat exchange?

*Shruti Singh*  
*Singh*  
*S*



# BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills

Session: 2019-20 (Summer / Winter Semester)

B. Voc. 3<sup>rd</sup> Semester,

End-Sem. Examination

Course Code: HVA-1303

Course Name: Air distribution

Instruction: Attempt all questions

*Answer key*

Time: 2 Hours

Max. Marks: 50

Set B

Section – A

10X01 = 10 Marks

1. a
2. a
3. d
4. b
5. d
6. a
7. a
8. d
9. b
10. b

Section – B

04X04 = 16 Marks

**1. Air contaminants:** - Indoor air contaminants can be solid or liquid particles, gases or vapors. Some can be irritants or odiferous, thus affecting occupant comfort. The same contaminants at higher concentrations, as well as others of which occupants may be unaware, can be health risks.

**Outdoor air requirements:** - It provides designers with a means of determining ventilation rates needed to achieve acceptable indoor air quality, which is defined as:

“air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction.”



Material	Applications	Advantages	Limitations
Galvanized Steel	Widely used for most air handling applications. Not recommended for corrosive product handling or temperatures above 200°C.	High strength, rigidity, durability, rust resistance in ordinary conditions, availability, nonporous, workability	Weldability, paintability, weight, corrosion resistance
Carbon Steel (Black Iron)	Breechings, flues, stacks, hoods, other high temperature duct systems, kitchen exhaust systems, ducts requiring paint or special coatings	High strength, rigidity, durability, availability, paintability, weldability, non-porous	Corrosion resistance, weight

3. Right-sizing of a heating, ventilation, and air-conditioning (HVAC) system is the selection of equipment and the design of the air distribution system to meet the accurate predicted heating and cooling loads of the house. The estimated heating and cooling loads are those required to meet the inside design conditions on the design load day. The design load day is not the most extreme weather conditions or the conditions that represent the majority of hours in a year. Temperature swings are expected in the conditioned space during extreme weather, and the system must be able to deliver comfort during the many hours of partial load conditions.

4. A VRV is a device that regulates flow of refrigerant, a variable such as temperature, velocity or pressure. Controls may be manual or automatic. For example, an air handling unit might have a manually set minimum flow of outside air and an automatic control to increase the outside air as the building becomes more densely occupied. If automatic, the implication is that the control is responsive to a measured change in pressure, temperature or some other variable to be regulated. Two common and important controls are dampers and thermostats. A damper is a device used to vary the volume of air passing through an outlet, inlet or duct. A thermostat is an automatic device that is responsive to temperature.

## Section – C

04X06 = 24 Marks

1. **Building characteristics:**-Determine building materials, areas, external surface colors and shapes from building plans and specifications.

**Building configuration:** Determine building location, orientation and external shading from building plans and specifications. Shading from adjacent buildings should be carefully evaluated as to its probable permanence before including it in the calculation. The possibility of abnormally high ground-reflected solar radiation (for example, from adjacent water, sand or parking lots), or solar load from adjacent reflective buildings should be considered.

**Thermal zones:**- The thermal zones within the building should be identified. For example, external offices with windows will have different thermal characteristics than windowless rooms in the building's interior. Additionally, some areas of the building may have to be kept at different temperatures than others.

**Building uses:**- The uses to which the building will be put will affect the levels of noise permissible in the building. For example, an office environment is typically less tolerant of noise from the HVAC system than a warehouse.



# BHARTIYA SKILL DEVELOPMENT UNIVERSITY

2.D. With the outlet devices selected and before duct layout and duct sizing can begin, the designer must determine how many zones of temperature control will be required for both perimeter zones and interior zones. In general, the exterior zone will be divided into zones that will be determined by building exposure (north, east, south or west exposure).

These perimeter zones may be further subdivided into smaller control zones, depending on variations in internal load or a requirement for individual occupant control. Typical situations would include private executive offices, where the owner may want individual control, or areas of high heat gain or loss such as computer rooms, conference rooms or corner rooms with two exposed walls.

Similarly, the interior zones may also be divided into control zones to satisfy individual room requirements or variations created by internal loads, such as lights, people or equipment.

**3. Air Handling Units :-** An air-handling unit (AHU) combines fans, coils, filters, dampers, connections to supply and return ducts, and other components into a device that moves air. It may also be used to clean, heat, cool, humidify, dehumidify and mix the air.

### Coils

A coil is a cooling or heating element made of pipe or tube. Coils are usually finned, and are found in a number of shapes (serpentine, helical, etc.).

### Ducts

A duct is a tube or conduit for conveying air. Ducts are classified in terms of application and pressure. HVAC systems in public assembly, business, educational, general factory and mercantile buildings are usually designed as commercial systems. Air pollution control systems, industrial exhaust systems and systems outside the pressure range of commercial system standards are classified as industrial systems.

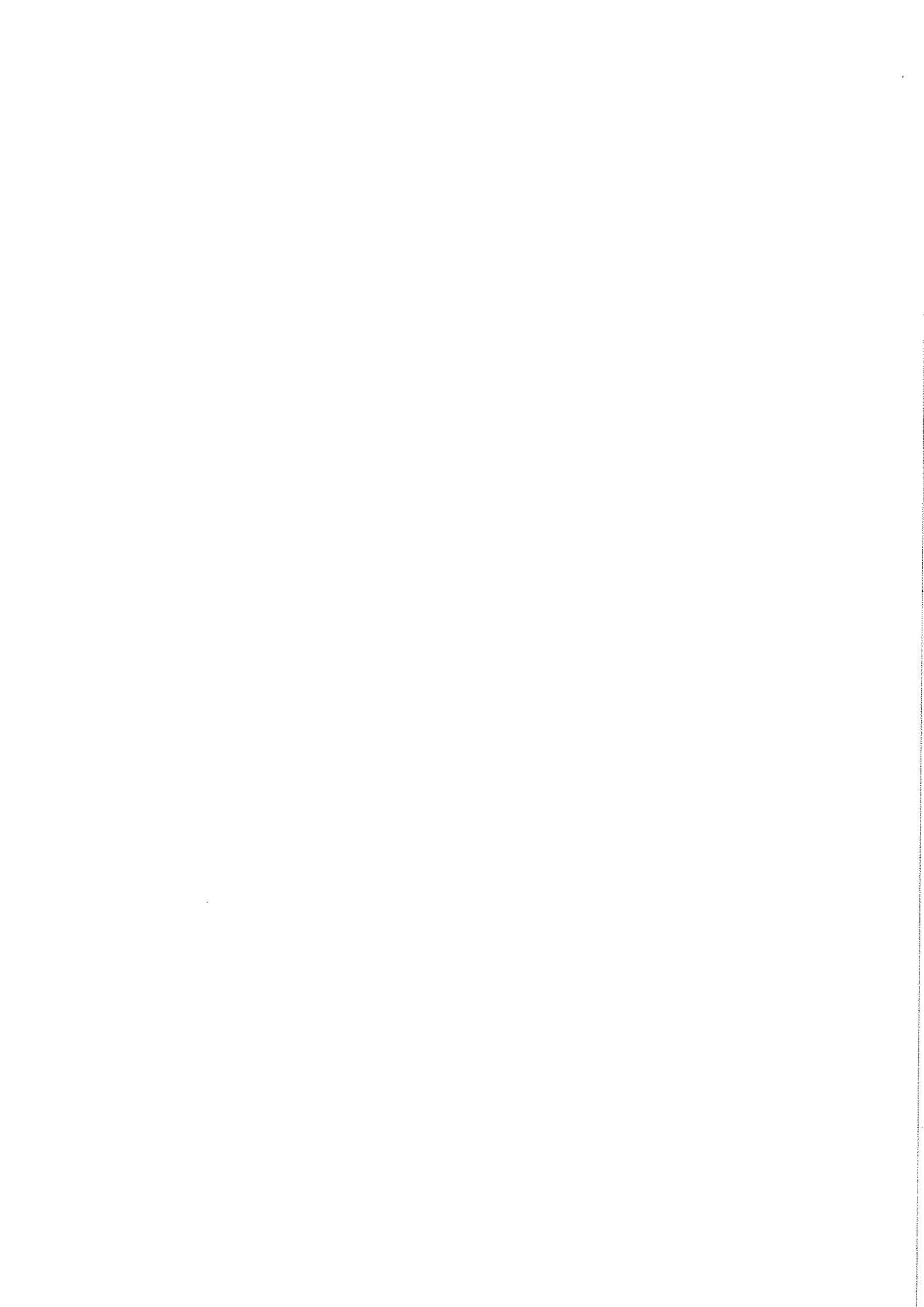
**4. Dry bulb/Wet Bulb temperature:** The air dry-bulb temperature is the temperature measured on an ordinary thermometer. Instruments used to measure wet-bulb temperatures are called psychrometers.

**Relative Humidity:** Relative humidity compares the amount of water in the air to the amount of water the air can hold at a given temperature.

**Thermal Radiation:** All objects, including human bodies, emit electromagnetic radiation. The wavelength of radiation emitted depends on the temperature of the objects. Such radiation is called thermal radiation.

**Air Movement:** Air movement may provide desirable cooling in warm conditions, but it may also increase the risk of unacceptably cool drafts.

*Handwritten signatures:*  
A  
D. Singh





School of RAC Skills

Session: 2020-21 (Summer Semester)

B. Voc. Program 3<sup>rd</sup> Semester

End-Sem. Examination

Course Code: HVA1304

Course Name: Thermal Insulation

Time: 2 Hours

Max. Marks: 50

Instruction:

- a) In section A, write option as well as complete answer.
- b) Calculator is allowed.

Set A  
Section – A

10X01 = 10 Marks

1. Formula of critical thickness of insulation through spherical wall.

- a)  $k/h$
- b)  $2k/h$
- c)  $h/2k$
- d)  $h/k$

2. Unit of convective heat transfer is?

- a)  $w/m^2 K$
- b)  $wm^2/K$
- c)  $w/mK$
- d)  $wm/K$

3. What is R-value?

- a) effectiveness of material in emitting energy as thermal conduction.
- b) Total Thermal resistance
- c) Total Thermal Conductance
- d) Total Resistance.

4. What is unit of perm

- a) 1 Grain/ hr ft in-Hg
- b) 1 Grain hr /ft<sup>2</sup> in
- c) 1 Grain/ hr ft<sup>2</sup> in-Hg
- d) 1 Grain ft<sup>2</sup>/ hr in-Hg

5. Which insulation has lowest working temperature?

- a) Rock Wool
- b) Plastic foams
- c) Glass wool
- d) Fiber Glass

6. Rock Wool is an example of?

- a) Mineral Wool
- b) Cellulose Insulation
- c) Loose insulation
- d) ceramic fiber

7. Working temperature Range of Cellular Glass Insulation is?



- a) 800 °F                      b) 900 °F                      c) 700 °F                      d) 1000°F

8. Working range of Elastomeric Insulation is?

- a) 200 to 250                      b) 300 – 800                      c) 50 – 450                      d) 100- 850

9. Cellulose insulation is made of?

- a) Sand                              b) Stone wool                      c) Slag                              d) Recycled paper and tree fibers

10. Elastomeric Foam insulation is also known as?

- a) EPS                              b) Stone wool                      c) XPS                              d) Expanded rubber foam

### Section – B

04X04 = 16 Marks

1. Write the Equation for heat transfer through plane wall (composite) by conductive heat transfer.
2. What is total thermal Resistance?
3. Write a short note on heat transfer by radiation.
4. What is critical thickness of insulation?

### Section – C

04X06 = 24 Marks

1. What are different modes of heat transfer, explain in details?
2. Write a short note on vapour barrier.
3. Describe the manufacturing processing of Glass Wool.
4. A steam pipe of 10 cm ID and 11 cm OD is covered with an insulating substance  $k = 1 \text{ W/m K}$ . The steam temperature is  $200^\circ\text{C}$  and ambient temperature is  $20^\circ\text{C}$ . If the convective heat transfer coefficient between insulating surface and air is  $8 \text{ W/m}^2\text{K}$ , find the critical radius of insulation for this value of  $r_c$ . Calculate the heat loss per meter of pipe and the outer surface temperature. Neglect the resistance of the pipe material.

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*Bugh*



# BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills

Session: 2020-21 (Summer Semester)

B. Voc. Program 3<sup>rd</sup> Semester

End-Sem. Examination

Course Code: HVA1304

Course Name: Thermal Insulation

Instruction:

- In section A, write option as well as complete answer.
- Calculator is allowed.

*Answer Key*

Time: 2 Hours

Max. Marks: 50

## Set A Section – A

10X01 = 10 Marks

1. Formula of critical thickness of insulation through spherical wall.  
b)  $2k/h$

2. Unit of convective heat transfer is?  
a)  $w/m^2 K$

3. What is R-value?  
b) Total Thermal resistance

4. what is unit of perm  
c) 1 Grain/ hr ft<sup>2</sup> in-Hg

05X01 = 05 Marks

5. Which insulation has lowest working temperature?  
b) Plastic foams

6. Rock Wool is an example of?  
a) Mineral Wool

7. Working temperature Range of Cellular Glass Insulation is?  
a) 800 °F

8. Working range of Elastomeric Insulation is?  
a) 200 to 250

9. Cellulose insulation is made of?  
d) Recycled paper and tree fibers

10. Elastomeric Foam insulation is also known as?

d) Expanded rubber foam

### Section – B

04X04 = 16 Marks

1. Write the Equation for heat transfer through plane wall (composite) by conduction.

**Answer:**

Heat Transfer through composite wall

Thermal resistances are added in the same way as electrical resistance.

So total resistance heat transfer through a plane composite wall we as follows.

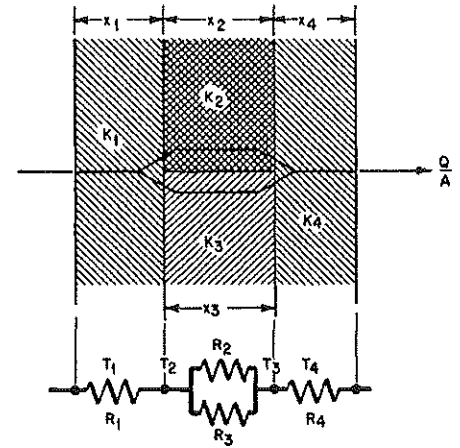
$$\frac{1}{R_{net}} = \frac{1}{R_1} + \frac{1}{R_2}$$

As we know

$$Q = (T_1 - T_2) / (R_1 + R_2)$$

then, total heat transfer will be

$$Q = \frac{T_1 - T_4}{R_1 + \frac{1}{\frac{1}{R_2} + \frac{1}{R_3}} + R_4}$$



2. What is total thermal Resistance?

**Answer:**

Thermal Resistance

it show how well a material resist flow of heat. It is opposite of thermal conductance it is denoted by "R".

$$R = 1/C$$

R-Value: the R-value is the thermal resistance per unit area of a material and is therefore dependent only on the thickness:

$$R\text{-value} = x/k$$

$$R_{total} = R_1 + R_2 + R_3 + \dots + R_n$$

3. Write a short note on heat transfer by radiation?

**Answer:**

Radiation is the transfer of energy through waves (electromagnetic radiation) or fast travelling particles (particulate radiation).

- Radiation can be in the form of heat, sound and light.
- Radiation can be felt or seen like light or detected through special instruments like X-ray.
- Radiation from a hot object is shorter and more intense than radiation from a cooler object.
- The Sun, Earth, soil, microwave, television, cell phones all expose us to radiation.

4. What is critical thickness of insulation?

**Answer**

**Critical thickness:**

The thickness up to which heat flow increases and after which heat flow decreases is termed as critical thickness. In the case of cylinders and spheres it is called critical radius. It can be derived the critical radius of insulation depends on the thermal conductivity of the insulation  $k$  and the external convection heat transfer coefficient  $h$ .



For Spherical coordinates  $r_{cr} = k/h$

For Spherical coordinates  $r_{cr} = 2k/h$

## Section – C

04X06 = 24 Marks

### 1. What are different modes of heat transfer, explain in details?

**Answer**

#### ● Conduction: -

Conduction is actually a process which takes place on an atomic-particle level. In metals, thermal conduction results from the motion of free electrons (similar to electrical conduction). In liquids and poorly conducting solids, oscillation of the molecular lattice is reason of conduction. In gases, conduction occurs through collisions between molecules.

$$Q = k A \frac{T_1 - T_2}{x}$$

Where:

- k is material of thermal conductivity.
- A is area
- T is temperature
- Convection: -

Heat transfer through convection, involves movement of fluid masses. There are two types of convection Natural and Forced. In Natural difference heat transfer occur when due to temperature difference there is a local density difference that makes pockets of fluid less or more buoyant than the surrounding fluid.

Both Natural and forced convection can be laminar, where heat flow dominated by conduction from the solid boundary, either turbulent where significant eddy mixing occur. If forced convection is not strong enough then this type of convection is known as mix convection.

#### ● Radiation

Radiation is the transfer of energy through waves (electromagnetic radiation) or fast travelling particles (particulate radiation).

- Radiation can be in the form of heat, sound and light.
- Radiation can be felt or seen like light or detected through special instruments like X-ray.
- Radiation from a hot object is shorter and more intense than radiation from a cooler object.
- The Sun, Earth, soil, microwave, television, cell phones all expose us to radiation

### 2. Write a short note on vapour barrier.

**Answer**

Any insulation will allow flow of heat of 10 times faster if it is wet than dry condition. So a layer of vapour barriers is required on surface of insulation material. Vapour is main source to make insulation wet. Cold air can't hold moisture, only warm air can. In cold areas vapour can enter from inside. Kitchen is one of the main source for vapour inside insulating space, that's why vapour barriers are required on internal surface

In warm humid areas vapour can enter in insulation from outside air, so external vapour barriers required on external surface.

If some areas have summer and winter on different times than both external and internal surface required vapour barriers.

Vapour in gases form is not harmful, but when it condensate or freezes then it is harmful.



### 3. Describe the manufacturing processing of Glass Wool.

#### Answer

#### Manufacturing Process:

1. Batch: glass wool is made mainly of sand, soda-ash, limestone and recycled glass; stored in silos, they are weighed, mixed and poured into a furnace.
2. Melting: the mixture is then melted at a temperature exceeding  $1,400^{\circ}\text{C}$  in an electric or gas furnace.
3. Fiberizing: the liquid glass passes via a feeder to a fiberizing machine, where it is propelled through tiny holes by a centrifugal spinner-creating the fibers. These are sprayed with a binder and shaped into a blanket.
4. Forming: then the blanket passes through a curing oven. During this process, the blanket can be compressed to achieve its final thickness.
5. Cutting: the blanket is then cut to the required width. Off-cuts are recycled. A facing can eventually be glued to the blanket.
6. Packaging: the end of the line is generally equipped with a rolling machine for mats and a stacking machine for boards.
7. Palletization: the glass wool can be compressed to up to a tenth of its volume. A total of 36 rolls of glass can be packed onto a single pallet.

#### Advantages:

- Long fibre, giving good tear strength.
- Suitable for temperatures up to  $230^{\circ}\text{C}$ .
- Non-combustible.
- Lightweight.
- Available in rolls and slabs.
- Corrosion resistant.

#### Disadvantages:

3. Can cause skin irritation.
4. Dust and fibres are a health risk.
5. Low deformation resistance unless properly supported.
6. Uneven surface – difficult to metal clad without supports.
7. Loses effectiveness if the insulation becomes wet or damp.

#### Applications:

- Loft or attic insulation.
- Cavity wall insulation.
- Sound insulation (absorption) within floors and partitions.
- Thermal and acoustic insulation of pipe work in heating and ventilation,
- air-conditioning and industrial applications.

4. A steam pipe of 10 cm ID and 11 cm OD is covered with an insulating substance  $k = 1 \text{ W/m K}$ . The steam temperature is  $200^{\circ}\text{C}$  and ambient temperature is  $20^{\circ}\text{C}$ . If the convective heat transfer coefficient between insulating surface and air is  $8 \text{ W/m}^2\text{K}$ , find the critical radius of insulation for this value of  $r_c$ . Calculate the heat loss per m of pipe and the outer surface temperature. Neglect the resistance of the pipe material.

#### Answer

$$R_i = 0.05\text{m}$$



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$$R_o = 0.55\text{m}$$

$$k = 1 \text{ W/mK}$$

$$T_i = 200 \text{ }^\circ\text{C} \quad T_o = 20 \text{ }^\circ\text{C}$$

$$h_o = 8 \text{ W/m}^2\text{K}$$

To find critical radius of insulation

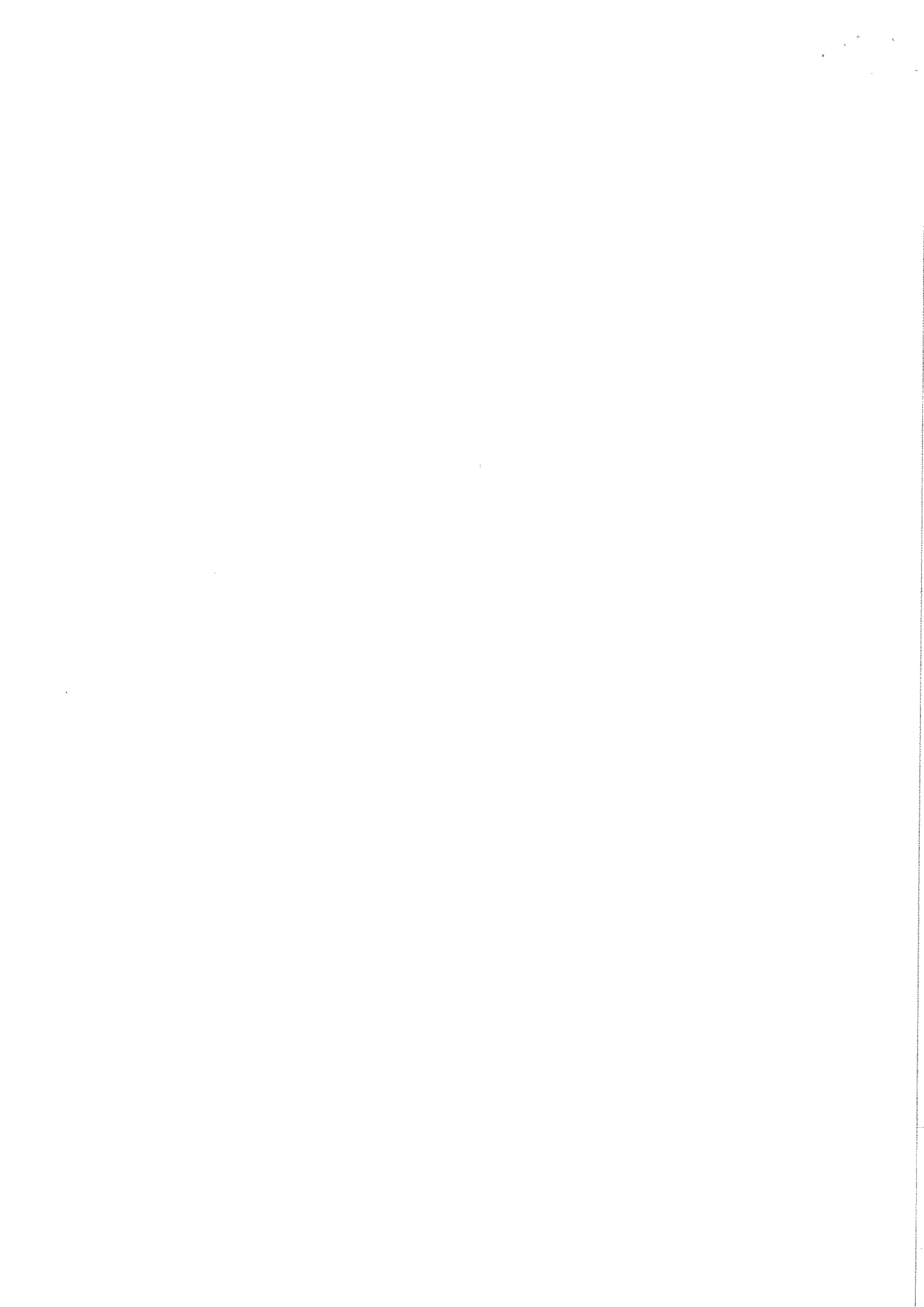
$$r_c = k / h_o = 1/8 = 0.125\text{m}$$

if critical radius is outer radius

$$\frac{Q}{L} = \frac{2\pi(T_o - T_\infty)}{\ln\left(\frac{r_c}{r_o}\right) + \frac{1}{k} + \frac{1}{h_o r_o}} = Q/L = \{ 2\pi (200 - 20) \} / \{ \ln(0.125/0.050) / 1 \} + (1/8 \times 0.125)$$
$$= 621 \text{ W/m}$$

Long

Design





School of RAC Skills

Session: 2020-21 (Summer Semester)

B. Voc. Program 3<sup>rd</sup> Semester

End-Sem. Examination

Course Code: HVA1304

Course Name: Thermal Insulation

Time: 2 Hours

Max. Marks: 50

Instruction:

1. In section A, write option as well as complete answer.
2. Calculator is allowed.

Set B  
Section – A

10X01 = 10 Marks

1. Formula of critical thickness of insulation through cylindrical wall.

- a)  $k/h$                       b)  $2k/h$   
c)  $h/2k$                       d)  $h/k$

2. Unit of conductive heat transfer is?

- a)  $W/m^2 K$                       b)  $Wm^2/ K$   
c)  $W/m K$                       d)  $W m / K$

3. What is unit of conductance?

- a)  $W/m.K$                       b)  $W/m^2.K$   
c)  $K. W/ m^2$                       d)  $K. m^2/ W$

4. Which insulation has lowest working temperature?

- a) Rock Wool                      b) plastic foams  
c) Glass wool                      d) fiber Glass

5. Glass Wool is an example of

- a) Mineral Wool                      b) Cellulosic Insulation  
c) Loose insulation                      d) Ceramic fiber

6. Which material catch fire comparative easily?

- a) Plastic Foams                      b) Ceramic fibers  
c) Calcium Silicate                      d) Loose insulation

7. Working range of PUF Insulation in degree centigrade is



- a) 200 to 110      b) 300 – 800  
c) 50 – 450      d) 100- 850

8. Which Formula represent thermal conductance?

- a)  $C = K \cdot A / X$       b)  $C = K / X$   
c)  $C = h / X$       d)  $C = k A$

9. Which Formula represent thermal resistance R?

- a)  $k A / X$       b)  $X / K A$   
c)  $1 / C A$       d)  $k / A x$

10. Which of following insulation material is non-combustible

- a) XPS      b) Mineral wool  
c) Cellulose fiber      d) ESP

**Section – B**

04X04 = 16 Marks

1. Write a short note on insulation thickness required to prevent condensation
2. Write a short note on heat transfer by convection
3. Write the Equation for heat transfer through cylindrical wall by conduction
4. What are R-value and U-value?

**Section – C**

04X06 = 24 Marks

1. Write a short not on natural insulation material.
2. Define the following properties of thermal Insulating material
  - (a) PERM
  - (b) Thermal Conductivity
3. Define following topics:
  - (a) Critical Thickness of insulation
  - (b) Thermal Resistance
4. Write short not on following topics
  - (a) Applications of rock wool
  - (b) Advantage and disadvantages of rock wool



School of RAC Skills

Session: 2020-21 (Summer Semester)

B. Voc. Program 3<sup>rd</sup> Semester

End-Sem. Examination

Course Code: HVA1304

Course Name: Thermal Insulation

Instruction:

- a) In section A, write option as well as complete answer.
- b) Calculator is allowed.

*Answer key*

Time: 2 Hours

Max. Marks: 50

Set B  
Section – A

10X01 = 10 Marks

1. Formula of critical thickness of insulation through cylindrical wall.

a)  $k/h$

2. Unit of conductive heat transfer is?

c)  $w/m K$

3. What is unit of conductance?

b)  $W/m^2.K$

4. Which insulation has lowest working temperature?

b) plastic foams

5. Glass Wool is an example of?

a) Mineral Wool

6. Which material catch fire comparative easily?

a) Plastic forms

7. Working range of PUF Insulation in degree centigrade is?

a) 200 to 110

8) Which formula represent Thermal Conductance?

a)  $C = K. A/ X$



9. Which Formula represent thermal resistance R?

b)  $X/KA$

10. Which of following insulation material is non-combustible

b) Mineral wool

Section – B

1. Write a short note on insulation thickness required to prevent condensation

Answer

$$x = \frac{k}{h_c + h_r} \left( \frac{T_s - T_i}{T_o - T_s} \right)$$

2. Write a short note on heat transfer by convection.

Heat transfer through Convection: -

Heat transfer through convection, involves movement of fluid masses. There are two types of convection Natural and Forced. In Natural difference heat transfer occur when due to temperature difference there is a local density difference that makes pockets of fluid less or more buoyant than the surrounding fluid.

Both Natural and forced convection can be laminar, where heat flow dominated by conduction from the solid boundary, either turbulent where significant eddy mixing occur. If forced convection is not strong enough then this type of convection is known as mix convection.  $Q = h A (T_s - T_f)$

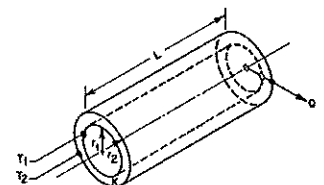
3. Write the Equation for heat transfer through cylindrical wall by conduction.

Answer

Heat Transfer through cylindrical wall or radial heat flow

As we know the

$$Q = \frac{2 \pi Lk}{\ln(r_2/r_1)} (T_1 - T_2)$$



for solving for thermal resistance from above equation

$$R = \frac{\ln(r_2/r_1)}{2 \pi Lk}$$



#### 4. What are R-value and U-value?

**Answer**

**R-Value and U-value: -**

R value shows how well a specific material resist the flow of heat. Higher the R-Value higher resistance in heat flow.

$$R\text{-Value} = \frac{\Delta T \times \text{Area} \times \text{time}}{\text{Heat loss}} = \frac{\text{F ft}^2 \text{Sec}}{\text{Btu}}$$

the R-value is the thermal resistance(R) per unit area of a material and is therefore dependent only on the thickness =  $RA = x/k$

U- Value is just opposite of R-Value; it is related with thermal conductivity.  $W/M^2 .K$  is unit of U-value,  $1/R$ - Value is also represent U-value.

$$Q = C (T_1 - T_2)$$

### Section – C

04X06 = 24 Marks

#### 1. Write a note on natural insulation material.

**Answer:**

- Human are using natural insulation from a very long time
- Different tree products like wood panels, fibber's, wood shaving etc., were being used as insulation products.
  - These organic materials provide high insulation properties but there is a disadvantage with these materials that they are highly reactive with water, that reduce their life span.
  - Reed panels were first used in the 19th century as thermal insulation mainly in ancillary buildings.
  - In 1920 the American Celotex Company introduced insulating panels made of bagasse (a waste by-product of sugar manufacturing).
  - The first cork insulating panels were produced in the 1870s.
  - In the early 20th century wood shavings and sawdust were very popular insulation products because their costs were very low and the raw material was readily available.
  - 20th century insulating blankets made of sheep's wool appeared on the market.

#### 2. Define the following properties of thermal Insulating material

(a) PERM

(b) Thermal Conductivity

**Answer:**

(a) **PERM:** By definition, a vapor barrier is a material that has a permanence of 1 "perm" or less. A perm is an English unit equal to 1 grain of vapor transmitted per hour per square foot per inch of mercury difference in vapor pressure; i.e.



1 PERM = 1 Grain/ hr ft<sup>2</sup> in-Hg

**(b) Thermal Conductivity:** Thermal conductivity occurs through molecular agitation and contact, and does not result in the bulk movement of the solid itself. Heat moves along a temperature gradient, from an area of high temperature and high molecular energy to an area with a lower temperature and lower molecular energy. This transfer will continue until thermal equilibrium is reached. The rate at which heat is transferred is dependent upon the magnitude of the temperature gradient, and the specific thermal characteristics of the material.

Thermal conductivity equation can be calculated using the following:

$$k = Q \times L / A (T_2 - T_1)$$

Where:

Q = heat flow (W)

L = length or thickness of the material (mm)

A = surface area of material (m<sup>2</sup>)

**3. Define following topics:**

**(a) Critical Thickness of insulation**

**(b) Thermal Resistance**

**Answer:**

**(a) Critical Thickness of insulation:**

The thickness up to which heat flow increases and after which heat flow decreases is termed as critical thickness. In the case of cylinders and spheres it is called critical radius. It can be derived the critical radius of insulation depends on the thermal conductivity of the insulation  $k$  and the external convection heat transfer coefficient  $h$ .

For Spherical coordinates  $r_{cr} = k/h$

For Spherical coordinates  $r_{cr} = 2k/h$

**(b) Thermal Resistance:**

It show how well a material resist flow of heat. It is opposite of thermal conductance it is denoted by "R".

$$R = 1/C$$

R-Value: the R-value is the thermal resistance per unit area of a material and is therefore dependent only on the thickness:

$$R\text{-value} = x/k$$

**4. Write short not on following topics**

**(a) Applications of rock wool**

**(b) Advantage and disadvantages of rock wool**

**Answer:**



## (a) Applications of rock wool

- Thermal insulation of flat roofs and external wall insulation.
- Fire protection, including smoke and fire barriers.
- High temperature applications.
- Sound insulation for floors and walls.
- Thermal and acoustic insulation of pipe work in heating and ventilation,
- air-conditioning and industrial applications.

## (b) Advantage and disadvantages of rock wool:

### Advantages

- Short fibre- compressive strength.
- Non-combustible suitable for temperatures up to 850° C
- Denser than glass mineral wool.
- Available in the form of slabs, rolls mattresses and pipe sections.
- High compressive strength.

### Disadvantages

- Dust and fibres are a health risk.
- Loses effectiveness if the insulation becomes wet or damp.
- Low deformation resistance unless properly supported.
- Uneven surface – difficult to metal clad without supports.

*Sanjiv*  
*Rangh* *A*





# BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

## School of Refrigeration & Air Conditioning Skills

Session: 2020-21 (Summer Semester)

B. Voc. Program, III Semester,

End-Sem. Examination

Course Code: HVA1305

Course Name: Electrical & Electronics safety testing

Instruction:

Time: 2 Hours

Max. Marks: 50

Set - A

Section - A

10X01 = 10 Marks

1. Most preferred control measures are :

A. PPE

B. Administrative controls

C. Isolate

D. Eliminate

2. Example of PPE:

A. hand gloves

B. insects

C. Radiation

D. Bacteria

3. Example of Hazard?

a. Slippery surface

b. measurement of happening

c. Use of Tools

d. Measurement of risk

4. What is VPP?

a. Voluntary Protection Plans

b. Voluntary Protection Plus

c. Voluntary Perfection Plans

d. Very Protection Plus

5. Benefits of health and safety programs are improvements in :

a. Product

b. Process

c. Service quality

d. All of the above

6. How many classes of fire extinguisher

a) One

b) Two

c) Three

d) Four

7. \_\_\_\_\_ extinguishers are suitable for use only on electrically energized fires

a) Class D

b) Class a

c) Class c

d) Class b

8. Squeeze the \_\_\_\_\_ of the fire extinguisher to release the extinguishing agent.





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Session: 2020-21 (Summer Semester)

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### ANSWER KEY

Course Code: HVA1305

Course Name: Electrical & Electronics safety testing

Instruction:

Time: 2 Hours

Max. Marks: 50

Set - A

#### Section – A

10X01 = 10 Marks

1. Most preferred control measures are :  
D) Eliminate
2. Example of PPE:  
a) Hand gloves
3. Example of Hazard.  
a) Slippery surface
4. What is VPP?  
a) Voluntary Protection Plan
5. Benefits of health and safety programs are improvements in :  
d) all of the above
6. How many classes of fire extinguisher  
d) Four
7. \_\_\_\_\_extinguishers are suitable for use only on electrically energized fires  
c) Class C
8. Squeeze the \_\_\_\_\_of the fire extinguisher to release the extinguishing agent.  
c) Nozzle
9. RCD's for protecting people have a rated tripping current (sensitivity) of not more than  
a) 30 milliampere
10. Safety rules can help prevent hazards associated with the use of hand and power tools?  
c) 4

#### Section – B

04X04 = 16 Marks

1. Calculate total capacitance value connected in series:  $2\mu\text{F}$ ,  $5\mu\text{F}$  and  $15\mu\text{F}$

Ans:

$$\begin{aligned} \frac{1}{C_{\text{TOTAL}}} &= \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} = \frac{1}{2} + \frac{1}{5} + \frac{1}{15} \\ &= 0.5 + 0.2 + 0.066 = 0.766\mu\text{F} \end{aligned}$$



A series connection capacitor will be added in the reverse of the total capacitance.

2. What is an inductor?

Ans:

An inductor is a passive electronic component which is capable of storing electrical energy in the form of magnetic energy. Basically, it uses a conductor that is wound into a coil, and when electricity flows into the coil from the left to the right, this will generate a magnetic field in the clockwise direction. Inductors are used as the energy storage device in many switched-mode power supplies to produce DC current. The inductor supplies energy to the circuit to keep current flowing during the "off" switching periods and enables topographies where the output voltage is higher than the input voltage.

3. What is Risk and Hazard? Explain by giving Examples.

Ans:

A hazard is a source or a situation with the potential for harm in terms of human injury or ill-health, damage to property, damage to the environment, or a combination of these.

Hazards at work may include noisy machinery, a moving forklift, chemicals, electricity, working at heights, a repetitive job, or inappropriate behaviour that adversely affects a workers safety and health.

Basically, a hazard is the potential for harm or an adverse effect (for example, to people as health effects, to organizations as property or equipment losses, or to the environment).

Sometimes the resulting harm is referred to as the hazard instead of the actual source of the hazard. For example, the disease tuberculosis (TB) might be called a "hazard" by some but, in general, the TB-causing bacteria (*Mycobacterium tuberculosis*) would be considered the "hazard" or "hazardous biological agent".

A risk is the chance of something happening that will have a negative effect. The level of risk reflects the likelihood of the unwanted event. The potential consequences of the unwanted event.

Risk is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard. It may also apply to situations with property or equipment loss, or harmful effects on the environment.

For example: the risk of developing cancer from smoking cigarettes could be expressed as:

- "cigarette smokers are 12 times (for example) more likely to die of lung cancer than non-smokers".

4. What is diode, explain its types?

Ans:



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A diode is a semiconductor device that essentially acts as a one-way switch for current. It allows current to flow easily in one direction, but severely restricts current from flowing in the opposite direction. ... When a diode allows current flow, it is forward-biased.

## Rectifier Diode

This is the most common and most used type of a diode. These types of diodes can handle heavy current and are used in converting AC into DC (Rectification).

## Schottky Diode

The Schottky diode, named after a German physicist Walter H. Schottky, is a type of diode which consists of a small junction between an N-type semiconductor and a metal. It has no P-N junction. The plus point of the Schottky diode is that it has very low forward voltage drop and fast switching. As there is no capacitive junction (P-N junction), the Schottky diode switching speed is very fast.

## Schottky Diode

The limitation of Schottky diodes is that it has low reverse breakdown voltage and high reverse leakage current.

## Super Barrier Diodes

Super barrier diodes (SBR) are also rectifier diodes but they have a low forward voltage drop just like a Schottky diode. They have low reverse leakage current just like a normal P-N junction diode. SBR uses MOSFET by making short contact between its gate and source.

## Section – C

04X06 = 24 Marks

1. Explain the hierarchy of controls.

Ans:

When we look at control measures we often refer to the hierarchy of control measures.

1. Eliminate the hazard

Elimination of the hazard is not always achievable though it does totally remove the hazard and thereby eliminates the risk of exposure. An example of this would be that petrol station attendants in Ireland are no longer exposed to the risk of chronic lead poisoning following the removal of lead from petrol products sold at forecourts.

2. Substitute the hazard with a lesser risk

Substituting the hazard may not remove all of the hazards associated with the process or activity and may introduce different hazards but the overall harm or health effects will be lessened. In laboratory research, toluene is now often used as a substitute for benzene. The



solvent-properties of the two are similar but toluene is less toxic and is not categorised as a carcinogen although toluene can cause severe neurological harm.

### 3. Isolate the hazard

Isolating the hazard is achieved by restricting access to plant and equipment or in the case of substances locking them away under strict controls. When using certain chemicals then a fume cupboard can isolate the hazard from the person, similarly placing noisy equipment in a non-accessible enclosure or room isolates the hazard from the person(s).

### 4. Use engineering controls

Engineering Controls involve redesigning a process to place a barrier between the person and the hazard or remove the hazard from the person, such as machinery guarding, proximity guarding, extraction systems or removing the operator to a remote location away from the hazard.

### 5. Use administrative controls

Administrative controls include adopting standard operating procedures or safe work practices or providing appropriate training, instruction or information to reduce the potential for harm and/or adverse health effects to person(s). Isolation and permit to work procedures are examples of administrative controls.

## 2. What is CPR, Explain the procedure to use this equipment?

If a person is not breathing, his heartbeat will stop. Do CPR (chest compressions and rescue breaths) to help circulation and get oxygen into the body. (Early use of an AED—an automated external defibrillator—if one is available, can restart a heart with an abnormal rhythm.

First, open a person's airway to check if they are breathing (don't begin CPR if a patient is breathing normally). Then, get help. If you are not alone, send someone to call for help as soon as you have checked breathing. Ask the person to come back and confirm that the call has been made. (Check out these emergency first-aid kit essentials.)

Then follow these CPR steps:

#### CPR Step 1

1. Position your hand (above). Make sure the patient is lying on his back on a firm surface. Kneel beside him and place the heel of your hand on the centre of the chest.

#### CPR step 2

2. Interlock fingers (above). Keeping your arms straight, cover the first hand with the heel of your other hand and interlock the fingers of both hands together. Keep your fingers raised so they do not touch the patient's chest or rib cage.

#### CPR step 3: Chest compressions



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the chest compressions (above). Lean forward so that your shoulders are directly over the patient's chest and press down on the chest about two inches. Release the pressure, but not your hands, and let the chest come back up.

Repeat to give 30 compressions at a rate of 100 compressions per minute. Not sure what that really means? Push to beat the Bee Gees song "Stayin' Alive." (Learn how to recognize the silent signs of a stroke.)

CPR step 4: Open the airway

PH

4. Open the airway (above). Move to the patient's head. Tilt his head and lift his chin to open the airway again. Let his mouth fall open slightly.

3. Explain different types of fire extinguishers?

Ans:

- Class A extinguishers will put out fires in ordinary combustibles such as wood and paper
- Class B extinguishers are for use on flammable liquids like grease, gasoline and oil
- Class C extinguishers are suitable for use only on electrically energized fires
- Class D extinguishers are designed for use on flammable metals

Multipurpose extinguishers can be used on different types of fires and will be labeled with more than one class, like A-B, B-C or A-B-C.

4. What is a transistor, what are its type and application, explain briefly?

Ans:

Transistor is a semiconductor device which is used to amplify the signals as well as in switching circuits. Generally transistors are made of solid material which contains three terminals such as emitter (E), Base (B) and Collector (C) for connections with other components in the circuit. Some transistors contain a fourth terminal also i.e. substrate (S).

Transistor is one of the active components.

Nowadays, the vacuum tubes are replaced with transistors because the transistors have more benefits over vacuum tubes. Transistors are small in size and it requires low voltage for operation and also it has low power dissipation. Due to these reasons the transistor is used in many applications such as amplifiers, switching circuits, oscillators and also in almost all electronic circuits

Types of Transistors

Transistors are the proper arrangement of different semiconductor materials. General semiconductor materials used for transistors are silicon, germanium, and gallium-arsenide. Basically the transistors are classified depending on their structure. Each type of transistors has their own characteristics, advantages and disadvantages.



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Transistors are designed primarily for switching purpose, other side some are designed for amplification purpose and some transistors are designed for both amplification and switching purposes. Depending on the structure the transistors are classified into BJT and FET.

### Junction Transistors

Junction transistor is generally called as Bipolar Junction Transistor (BJT). The BJT transistors have three terminals named emitter (E), Base (B), Collector (C). The name itself indicates that it has two junctions between p-type and n-type semiconductors. The BJT transistors are classified into NPN and PNP transistors depending on the construction.

### FET (Field Effect Transistor)

The Field-Effect-Transistor (FET) is another transistors type. Basically the FET transistors have three terminals they are gate (G), Drain (D) and Source (S). FET transistors are classified into Junction Field Effect transistors (JFET) and Insulated Gate FET (IG-FET) or MOSFET transistors. For the connections in the circuit we also consider fourth terminal called base or substrate. The FET transistors have control on the size and shape of a channel between source and drain which is created by applied voltage. The FET transistors are uni-polar transistors because they perform single channel operation where as BJT transistors are bipolar junction transistors. The FET transistors have high current gain than BJT transistors

### JFET (Junction-Field Effect Transistor)

The Junction-Field-Effect transistor (JFET) is an earliest and simple type of FET transistors. These JFETs are used as switches, amplifiers and resistors. This transistor is a voltage controlled device. It doesn't need any biasing current. The voltage applied between gate and source controls the flow of electric current between source and drain of a transistor. The JFET transistors are available in both N-channel and P-channel types.

### MOSFET

Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET) is the most useful type among all transistors. The name itself indicates that it contains a metal gate terminal. The MOSFET has four terminals: drain, source, gate and body or substrate (B). MOSFET has many advantages over BJT and JFET, mainly it offers high input impedance and low output impedance. It is used in low power circuits mainly in chip designing technologies.

Rough



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Registration No.: .....

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Session: 2020-21 (Summer Semester)

B. Voc. Program, III Semester,

End-Sem. Examination

Course Code: HVA1305

Time: 2 Hours

Course Name: Electrical & Electronics safety testing

Max. Marks: 50

Instruction:

Set - B

Section – A

10X01 = 10 Marks

1. Definition of Hazard?
  - a. Anything that can cause harm
  - b. Use of Equipment
  - c. Use of Tools
  - d. Measurement of risk
  
2. Type of Chemical Hazard:
  - a. Noise
  - b. Tools
  - c. Welding
  - d. None of the above
  
3. Biological Hazards Include?
  - a. Virus
  - b. Bacteria
  - c. Insects
  - d. All of the above
  
4. Machine guards, as appropriate, must be provided to protect the operator and others from the following:
  - a. Point of operation.
  - b. In-running nip points.
  - c. Rotating parts.
  - d. All of the above.
  
5. When using a powered grinder:
  - a. Always use eye or face protection.
  - b. Turn off the power when not in use.
  - c. Both a & b
  - d. None of the above
  
6. The RCD has a \_\_\_\_\_ to check that its mechanism is free and functioning and should be used regularly.
  - a) Press button
  - b) Pull button
  - c) Test button
  - d) None
  
7. Aim the fire extinguisher low, with the \_\_\_\_\_ pointed at the base of the fire
  - a) Head
  - b) Nozzle
  - c) Hose
  - d) Cylinder



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8. Instead of being round for full stop (like prohibition signs), you can remember that mandatory signs are round for

- a) Forget
- b) Obey
- c) Disobey
- d) None of the above

9. Management leadership includes:

- A. Creates a culture of safety
- B. facilitate trust
- C. Reinforce the core elements
- D. All of the above

10. To prevent hazards associated with the use of power tools, workers should observe the following general precautions:

- a. Never carry a tool by the cord or hose.
- b. Never yank the cord or the hose to disconnect it from the receptacle.
- c. Keep cords and hoses away from heat, oil, and sharp edges.
- d. All of the above

## Section – B

04X04 = 16 Marks

1. Calculate total capacitance value connected in series:  $7\mu\text{F}$ ,  $5\mu\text{F}$  and  $15\mu\text{F}$ .
2. What is a capacitor?
3. Explain the health and safety signs in detail.
4. What are the hazards of hand tools?

## Section – C

04X06 = 24 Marks

1. Explain the direct and indirect cost of an accident.
2. Explain first aid when getting an electric shock?
3. What is the role of education and training in reducing hazards in the workplace.
4. What are the different types of hazards in the workplace. Explain with examples.



**School of Refrigeration & Air Conditioning Skills**

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**ANSWER KEY**

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**Time: 2 Hours**

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**Max. Marks: 50**

**Instruction:**

Set - B

**Section – A**

10X01 = 10 Marks

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  - a) Anything that can cause harm
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  - d) None of the above
3. Biological Hazards Include?
  - d) All of the above
4. Machine guards, as appropriate, must be provided to protect the operator and others from the following:
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5. When using a powered grinder:
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6. The RCD has a \_\_\_\_\_ to check that its mechanism is free and functioning and should be used regularly.
  - d) Test Button
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  - b) Obey
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**Section – B**

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1. Calculate total capacitance value connected in series:  $7\mu\text{F}$ ,  $5\mu\text{F}$  and  $15\mu\text{F}$ .



$$\begin{aligned} 1/CTOTAL &= 1/C1 + 1/C2 + 1/C3 = 1/7 + 1/5 + 1/15 \\ &= 0.142 + 0.2 + 0.066 = 0.4088 \mu F \end{aligned}$$

A series connection capacitor will be added in the reverse of the total capacitance.

2. What is a capacitor?

Ans:

The capacitor is a component which has the ability or "capacity" to store energy in the form of an electrical charge producing a potential difference (Static Voltage) across its plates, much like a small rechargeable battery.

There are many different kinds of capacitors available from very small capacitor beads used in resonance circuits to large power factor correction capacitors, but they all do the same thing, they store charge.

In its basic form, a capacitor consists of two or more parallel conductive (metal) plates which are not connected or touching each other, but are electrically separated either by air or by some form of a good insulating material such as waxed paper, mica, ceramic, plastic or some form of a liquid gel as used in electrolytic capacitors. The insulating layer between capacitor plates is commonly called the Dielectric.

3. Explain the health and safety signs in detail.

Ans:

There are 5 health and safety signs, and they all mean different things.

The 5 types of health and safety signs are:

- Prohibition Signs
- Mandatory Signs
- Warning Signs
- Safe Condition Signs
- Fire Equipment Signs

Every type of health and safety looks different. Through shape and colour combinations, they can send their message through just a picture or icon. Once you know what you are looking for, you can quickly understand the exact meaning of the sign (even without reading the words)

4. What are the hazards of hand tools?

Ans:



Hand tools are tools that are powered manually. Hand tools include anything from axes to wrenches. The greatest hazards posed by hand tools result from misuse and improper maintenance.

Some examples include the following:

If a chisel is used as a screwdriver, the tip of the chisel may break and fly off, hitting the user or other employees.

If a wooden handle on a tool, such as a hammer or an axe, is loose, splintered, or cracked, the head of the tool may fly off and strike the user or other employees.

## Section – C

04X06 = 24 Marks

1. Explain the direct and indirect cost of an accident.

Ans:

When we look at control measures we often refer to the hierarchy of control measures.

Direct costs are usually the cost of insurance increases that you might experience as a result of that accident such as a rate increase due to increased accident frequency or severity and any out-of-pocket costs you have associated with damages, such as a direct payment to a third party or your deductible. Indirect costs are those costs that are not direct damage expenses, pre-funded loss allocations or losses covered by insurance.

The indirect costs or hidden costs might include:

Lost productivity due to the absence of an injured worker or workers. Lost productivity of employees who assist in the rescue, cleanup, and repairs caused by an accident.

The cost to repair or replace damaged property, equipment or vehicles.

Rental costs while equipment or vehicles are repaired. The loss of a revenue stream or contract. Damage to an organization's public image. Overtime expenses incurred by additional staff needed to make up for the lost worker or workers. Lost time of supervisors and management who must respond to the accident

2. Explain first aid when getting an electric shock?

1. Separate the Person From Current's Source

To turn off power:

Unplug an appliance if the plug is undamaged or shut off power via circuit breaker, fuse box, or outside switch.

2. Do CPR, if Necessary

When you can safely touch the person, do CPR if the person is not breathing or does not have a pulse.



### 3. Check for Other Injuries

If the person is bleeding, apply pressure and elevate the wound if it's in an arm or leg.

### 4. Wait for 911 to Arrive

### 5. Follow Up

A doctor will check the person for burns, fractures, dislocations, and other injuries.

An ECG, blood tests, urine test, CT scan, or MRI may be necessary

### 3.What is the role of education and training in reducing hazards in the workplace.

Ans:

Education and training are important tools for informing workers and managers about workplace hazards and controls so they can work more safely and be more productive. Another role of education and training, however, is to provide workers and managers with a greater understanding of the safety and health program itself, so that they can contribute to its development and implementation. Education and training provides employers, managers, supervisors, and workers with Knowledge and skills needed to do their work safely and avoid creating hazards that could place themselves or others at risk. Awareness and understanding of workplace hazards and how to identify, report, and control them. Additional training may be needed depending on the roles assigned to employers or individual managers, supervisors, and workers. For example, employers, managers, and supervisors may need specific training to ensure that they can fulfill their roles in providing leadership, direction, and resources for the safety and health program. Workers assigned specific roles in the program (e.g., incident investigation team members) may need training to ensure their full participation in those functions.

Effective training and education can be provided outside a formal classroom setting.

Peer-to-peer training, on-the-job training, and worksite demonstrations can be effective in conveying safety concepts, ensuring understanding of hazards and their controls, and promoting good work practices.

### 4.What are the different types of hazards in the workplace.Explain with examples.

Ans:

Biological - bacteria, viruses, insects, plants, birds, animals, and humans, etc. Biological hazards include viruses, bacteria, insects, animals, etc., that can cause adverse health

Chemical - depends on the physical, chemical and toxic properties of the chemical, Chemical hazards are hazardous substances that can cause harm. These hazards can result in both health and physical impacts, such as skin irritation, respiratory system irritation, blindness, corrosion and explosions.



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Ergonomic - repetitive movements, improper setup of workstation, etc. Ergonomic hazards are a result of physical factors that can result in musculoskeletal injuries. For example, a poor workstation setup in an office, poor posture and manual handling.

Physical - radiation, magnetic fields, pressure extremes (high pressure or vacuum), noise, etc. Physical hazards are environmental factors that can harm an employee without

necessarily touching them, including heights, noise, radiation and pressure. Psychosocial or

Workplace Hazards - stress, violence, etc. Psychosocial hazards include those that can have

an adverse effect on an employees mental health or wellbeing. Safety - slipping/tripping

hazards, inappropriate machine guarding, equipment malfunctions or breakdowns. These

are hazards that create unsafe working conditions.

*Rugh*  
*A*

